For Reference

Not to be taken from this room

Graduate School of Arts and Sciences Northeastern University 1982–84

400 Meserve Hall
360 Huntington Avenue
Boston, Massachusetts 02115
Telephone: 617-437-3980

contents

4 **Campus Map**
5 **Academic Calendar**
9 **The University**
15 **Buildings and Facilities**
19 **The Graduate School of Arts and Sciences**
19 General Regulations
23 The Master's Degree
24 The Doctor of Philosophy Degree
26 Interdisciplinary Programs
28 **Financial Information**
28 Financial Obligations
29 Financial Aid
33 **Fields of Study**
34 Biology
48 Chemistry
57 Clinical Chemistry
62 Forensic Chemistry
66 Economics
79 English
93 History
102 Law, Policy, and Society
110 Mathematics
122 Physics
133 Political Science
150 Psychology
158 Sociology and Anthropology
177 **The Governing Boards and Officers of the University**
177 The Northeastern University Corporation
180 Board of Trustees
181 Administrative Organization
183 General University Committees
184 Organization of the Graduate Schools
186 Committee of the Graduate School of Arts and Sciences
187 **Index**

NORTHEASTERN UNIVERSITY
BOSTON, MASSACHUSETTS
SCALE
STREET DIRECTION
PARKING
Back Bay/Fens
FENWAY
HEMENWAY ST
GAINSBOROUGH ST
FORSYTH WAY
FORSYTH WAY
SPEARE PL
ST STEPHEN ST
OPERA PL
SPEARE PARKING AREA
NORTH PARKING AREA
Museum of Fine Arts
HUNTINGTON AVENUE (ROUTE 9)
MUSEUM VILLA
PARKER ST
TAVERN PARKING AREA
FIELD ST PARKING NO. 1
FIELD ST PARKING NO. 2
LEON PARKING AREA
DAVENPORT
LAW SCHOOL EXTENSION
STEARNS
CURRIER
DODGE
CABOT
RICHARDS
HAYDEN
FORSYTH
CHURCHILL
DANA
HAYDEN PARKING AREA
ELL
WVBR
ROBINSON PARKING AREA
HURTIG
WILLIAMS
FORSYTH ST
FORSYTH WEST PARKING
RUGGLES ST
RUGGLES
RUGGLES PARKING AREA
SOUTH PARKING AREA
MBTA
COLUMBUS PARKING EAST
COLUMBUS AVENUE
COLUMBUS PARKING WEST
YMCA PARKING
BOSTON PH
ST BOTOLPH ST
Boston YMCA
New England Conservatory of Music
N.U. Annex
Symphony Hall
Christian Science Center
Prudential Center
Mass. Pike
KEY
UNDERGROUND TUNNELS
PARKING AREAS
ROUTE FOR HANDICAPPED
PARKING FOR HANDICAPPED
5/82

ACADEMIC CALENDAR 1982–83

Fall Quarter 1982

Registration period		
Burlington	Sept. 14–15	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	Sept. 20–23	1:00-8:00 p.m.
Classes begin (4:00 p.m. or later)	Sept. 27	
Last day to drop a course without receiving a "W"	Oct. 29	
Examination period	Dec. 13–18	

Winter Quarter 1982–1983

Registration period		
Burlington	Nov. 30	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	Dec. 6–9	1:00–3:00 p.m., 5:30–8:00 p.m.
Classes begin (4:00 p.m. or later)	Jan. 3	
Last day to drop a course without receiving a "W"	Feb. 4	
Examination period	March 21–26	

Spring Quarter 1983

Registration period		
Burlington	March 8	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	March 14–17	1:00–3:00 p.m., 5:30–8:00 p.m.
Classes begin (4:00 p.m. or later)	April 4	
Last day to drop a course without receiving a "W"	May 6	
Examination period	June 13–18	
Spring Commencement	June 19	

Summer Quarter 1983

Registration period		
Burlington	June 13–14	5:30–8:00 p.m.
Boston	June 15–16	5:30–8:00 p.m.
Classes begin (4:00 p.m. or later)	June 27	

UNIVERSITY HOLIDAYS 1982–83

Columbus Day	Monday	October 11
Veterans Day	Thursday	November 11
Thanksgiving Recess	Thursday–Saturday	November 25–28
Christmas Vacation	Monday–Saturday	Dec. 20–Jan. 2
Martin Luther King, Jr., Day	Saturday	January 15
Washington's Birthday	Monday	February 21
Patriot's Day	Monday	April 18
Memorial Day	Monday	May 30
Independence Day	Monday	July 4
Labor Day	Monday	September 5

Emergency Closing of the University Northeastern University has made arrangements to notify students, faculty, and staff by radio when it becomes necessary to cancel classes because of extremely inclement weather. Radio stations WBZ, WEEI, WHDH, WHUE, WJDA, WCOZ–FM, WRKO, WLYN–FM, WKOX, WHAV, WVBF-FM, WRBB, WLLH and WBCN will announce the University's decision to close.

Equal Opportunity Policy Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admissions, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of non discrimination.

Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age, national origin, or on the basis of being a handicapped, but otherwise qualified individual. Further, Northeastern will not condone any form of sexual harassment.

Inquiries concerning our equal opportunity policies may be referred to the University Title IX Coordinator/Compliance Officer for Section 504 of the Rehabilitation Act of 1973, Affirmative Action Office, 175 Richards Hall (617) 437-2133.

Family Educational Rights and Privacy Act In accordance with the Family Educational Rights and Privacy Act of 1974, Northeastern University permits its students to inspect their records wherever appropriate and to challenge specific parts of them when they feel it necessry to do so. Specific details of the law as it applies to Northeastern are printed in the *Student Handbook* and are distributed annually at registrations of University College and the graduate schools.

Office of Services for the Handicapped The Office of Services for the Handicapped (OSH) provides a variety of support services and general assistance to all of Northeastern's disabled students and employees. The University's efforts to comply with the Rehabilitation Act of 1973 are coordinated by Ruth Bork, OSH Director, 5 Ell Center, (617) 437-2675.

Delivery of Services The University assumes no liability, and hereby expressly negates the same, for failure to provide or delay in providing educational or related services or facilities or for any other failure or delay in performance arising out of or due to causes beyond the reasonable control of the University, which causes include, without limitation, power failure, fire, strikes by University employees or others, damage by the elements and acts of public authorities. The University will, however, exert reasonable efforts, when in its judgment it is appropriate to do so, to provide comparable or substantially equivalent services, facilities or performance, but its inability or failure to do so shall not subject it to liability.

The Northeastern University catalog contains *current information* regarding the University calendar, admissions, degree requirements, fees, and regulations, and such information is not intended to be and should not be relied upon as a statement of the University's contractual undertakings.

Northeastern University reserves the right in its sole judgment to promulgate and change rules and regulations and to make changes of any nature in its program, calendar, admissions policies, procedures and standards, degree requirements, fees, and academic schedule whenever it is deemed necessary or desirable, including, without limitation, changes in course content, the rescheduling of classes, cancelling of scheduled classes and other academic activities and requiring or affording alternatives for scheduled classes or other academic activities, in any such case giving such notice as is reasonably practicable under the circumstances.

We at Northeastern will do our best to make available to you the finest education we can provide, the most stimulating atmosphere in which to learn, and the most congenial conditions under which you may enjoy the learning experience. But the quality and the rate of progress of your academic career is in larger measure dependent upon your own abilities, commitment, and effort. You will be a full participant in an educational partnership. We will and, indeed, can only make the opportunities available to you; it is up to you to take advantage of them.

This is equally true with your career upon graduation. We cannot guarantee that you will obtain any particular job; that will depend upon your own skills, achievement, presentation, and other factors such as market conditions at that time. Similarly, in many professions and occupations there are increasing requirements imposed by federal and state statutes and regulatory agencies for certification or entry into a particular field. These may change during the period of time when you are at Northeastern and they may vary from state to state. While we will be ready to help you find out about these requirements and changes, it is your responsiblity to initiate the inquiry because we cannot know what your expectations and understandings are unless you tell us.

In brief, what we are saying to you is that we are here to offer you educational opportunities and choices and to assist you in defining the direction in which you want to steer your educational experience. But you are a partner in this venture with an obligation and responsiblity to yourself.

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time.

NORTHEASTERN
BEATLES
ASS ALE

the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The state legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not attempted to duplicate the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan of Education initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922); Liberal Arts (1935); Education (1953); Pharmacy (1962); Nursing (1964); Boston-Bouvé College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method offers students the opportunity to gain valuable practical experience as an integral part of their college program and often provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses—offered by the University since 1906—and adult day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The eight graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, Doctor of Philosophy, and a Certificate of Advanced Graduate Study in Advanced Literary Study.

The Graduate School of Boston-Bouvé College of Human Development Professions offers the degrees of Master of Science, Master of Education, Doctor of Education, and the Certificate of Advanced Graduate Study.

The Gradute School of Business Administration offers the degree of Master of Business Administration.

The Graduate School of Criminal Justice offers the degree of Master of Science.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science, Doctor of Philosophy, and Doctor of Pharmacy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education, located in Waltham, Massachusetts, serves the educational needs of the community through workshops, conferences, special programs, and public offerings. Programs include State-of-the-Art Engineering, Supervisory Management, Emergency Medical Technician, Paramedic, Graphic Arts, Food Industry, Paralegal, and many other specialized areas of interest. The center awards nationally recognized Continuing Education Units (CEUs) to students who satisfactorily complete the programs. For further information about the Center's programs, telephone 617-890-1134.

RESEARCH

Northeastern University recognizes the importance of high quality research as an essential ingredient of academic life. The University's maturing focus on research takes into account not only the intrinsic value of specific research projects, but it also acknowledges the importance of research as a vital and integral part of graduate education.

Responsibility for fostering and coordinating the development of research at Northeastern resides with the vice provost for Research and Graduate Studies. Assisting him is the University Council on Research and Scholarship which serves as an advisory body for dealing with broad policy issues as well as with procedures for encouraging and facilitating research and scholarship. The administrative support for research projects and training programs is provided by the Office of Sponsored Programs whose services include the preparation and transmittal of proposals and reports, the monitoring of contracts and grant funds and assistance in locating sources of support. A recently introduced newsletter entitled *Re:Search* brings information about the research and scholarly efforts of Northeastern's faculty and students to the University community and the general public.

Faculty and graduate students receive funding for their research from a variety of sources including government agencies, private industry, and foundations. The National Institutes of Health, National Science Foundation, the National Endowment for the Humanities, IBM, Dow Chemical, and the Mellon Foundation are but a few of the organizations providing support. The University also contributes to many research projects through its own Research and Scholarship Development Fund. The fund was established to stimulate new ventures in research and scholarship and to provide seed money for the exploration of new ideas and approaches to problems which are likely to lead to high quality publications and extramural support.

Northeastern University has numerous distinguished faculty members, many of whom have received prestigious awards, including Sloan Scholarships, Guggenheim Fellowships, and National Institutes of Health Research Awards. Faculty members lecture the world over. Additionally, many faculty members serve as United States government consultants and participate on a variety of national and international committees.

Current research activities span almost every academic field and include laboratory projects, theoretical studies, and technological applications. Research is under way in the areas of business, physical and biological sciences, social sciences, humanities, allied health professions, and engineering. Student participation in these activities can take place as part of regular academic programs in the form of specially-designed independent studies, or through cooperative work assignments. Research involvement is actively encouraged and is limited only by the student's own motivation and curiosity.

The following summary of research represents just a small sample of the multitude of projects now underway throughout the University.

In the College of Arts and Sciences, research projects reflect the diversity of its nineteen departments. Research in the humanities and natural and social sciences includes studies in nineteenth century Boston architecture, the Off-Off Broadway theater, cable TV, quantum field theory, and infrared spectroscopy.

As part of the College's interdisciplinary interest in marine sciences, the Marine Science and Maritime Studies Center has been established. At the Nahant field station and laboratory of this Center, faculty and graduate students perform studies in marine chemistry, biology, and botany.

The nature of research in Boston-Bouvé College of Human Development Professions is broad in range and diverse in approach. Changes in human development and the roles of the teacher and clinician in facilitating such changes are topics of lively interest. Some of the current research interests of the College include the communication abilities in normal and hearing-impaired individuals, the role of exercise in cardiovascular health and disease, the relationship between age change and the development of motor and cognitive skills in children, the evaluation of clinical practice in physical therapy, and educational practices in the schools, and the examination of barriers to the employment of the disabled in leisure services.

Research in the College of Business Administration is divided between the theoretical and practical aspects of management, human resources, and marketing. New ideas in corporate practice and theory are conceived through in-

vestigations that include high technology, small business entrepreneurship, and foreign investment in developing countries. Other studies cover U.S. transportation problems, federal regulatory agencies, and technology forecasting for emerging high technology firms.

The College of Criminal Justice is one of the few institutions in the United States where crime and law are studied from interdisciplinary viewpoints. The focus of research in this College is on crime detection and prevention, industrial espionage, private security systems, and contemporary terrorism.

Research in the College of Engineering encompasses some of today's most important technological issues. Robotics, CAD/CAM, telecommunications, and space rocketry design are some of the areas under investigation. The College maintains close ties with industry, thereby augmenting facilities and professional expertise. Other research activities deal with environmental, health, and transportation concerns.

The School of Law's research topics include an historical look at the Securities and Exchange Commission and studies of the new civil procedures. One project deals with the effects of the landmark *Tarasoff* court case on the mental health profession. National law school curricula policies are also under investigation.

The College of Nursing is addressing some of the important problems currently facing the entire nursing profession. An answer to nursing burnout is sought in the College's new school nurse practitioner program. Assessments of this new direction in nursing, and other employment possibilities and problems, are areas in which the faculty are directing their research efforts.

Research studies in the College of Pharmacy and Allied Health Professions include topics such as new analytical methods for antidepressant and anticonvulsant drugs, the synthesis of new drugs, improving diagnostic techniques for cancer of the bladder, and the study of clinical applications in respiratory therapy.

The Cooperative Education Research Center is concerned with the social and educational impact of the cooperative education mode. Through statistical surveys, data on cooperative education are compiled. Conclusions reached at this Center have important implications for future college costs, career opportunities, and educational priorities.

Northeastern also has several interdisciplinary centers and institutes in which research spanning several disciplines is performed.

The Institute of Chemical Analysis, Applications, and Forensic Science carries out basic research in analytical chemistry and material science. The Institute is also concerned with applications of these fields in industry, environmental regulatory agencies, and law and police departments. It has an international reputation in the fields of chromatography, mass spectrometry, amorphous metals, and solar energy storage devices.

The Center for Electron Microscopy provides advanced scientific equipment for the training of scientists and the performance of research into cellular and subcellular structures.

The Institute for the Interdisciplinary Study of Education serves as a center

for the exchange of ideas on critical issues in education. The high technology industry, South African education, and community college programs for prisoners are topics of current research.

The Center for Applied Social Research is a nationally known center for studies dealing with current public and social policy issues. Projects are presently underway in the fields of criminal justice, public safety, mental health, social welfare, and education.

Northeastern University is accredited by the New England Association of Schools and Colleges, Inc., which accredits schools and colleges in the six New England states. Accreditation by the Association indicates that the institution has been carefully evaluated and found to meet standards agreed upon by qualified educators.

buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The 50-acre campus is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Some are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering; Chemistry and Biology; Mathematics and Psychology; and Health, Physical and Recreation Education, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science and Maritime Studies Center at Nahant.

The library collections number 470,000 volumes supplemented by some 550,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, some 3,876 periodical titles and more than 5,000 sound recordings.

Marine Science and Maritime Studies Center

The Marine Science and Maritime Studies Center at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is located about 20 miles northeast of Boston. Many of the courses at the Institute are applicable toward an advanced degree in biology or health science.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. The large gymnasium contains four basketball courts. In addition, the Center consists of an athletic cage, a small gymnasium, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston Bouvé College of Human Development Professions.

An addition to the center, the Barletta Natatorium, houses a 105-foot swimming pool, a practice tank for the crew, handball and racquetball courts, and shower and dressing facilities.

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Warren Center

The Warren Center is located on 165 acres in Ashland, Massachusetts, thirty miles west of Boston. The Center provides an outdoor laboratory for students of physical education and recreation and leisure studies at Northeastern's Boston-Bouvé College of Human Development Professions. However, the Warren Center invites the use of the Center by Northeastern's staff, faculty, alumni, and students, and welcomes other educational groups seeking enrichment in an outdoor setting. The Center offers woods, fields, and a lake as well as tennis courts, an archery range, camp sites, an outdoor pavilion, a lodge that can accommodate up to 150 people in its dining room, heated cabins, a health lodge, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is located 12 miles from the main campus.

Northeastern Arena

Two blocks and a right turn away from the main quadrangle on Northeastern University's campus is the oldest indoor ice hockey arena in the United States and one of the focal points for amateur athletics in the Boston area.

Today, the Arena is primarily devoted to hockey and collegiate sports, but has expanded its university athletic focus to include all men's basketball contests and many women's varsity contests.

With more than a million and a half dollars already invested in the Arena, the building is a jewel to the eye and a credit to the community. So long as Northeastern owns the Arena, it will continue to meet the needs of the surrounding community as a superior recreational facility.

the graduate school of arts and sciences

Ten departments in the College of Arts and Sciences offer work at the graduate level. The Master of Arts degree may be earned in economics, English, history, political science, psychology, sociology, and social anthropology. The Master of Science degree is awarded in biology, chemistry, economic policy and planning, mathematics, and physics. The Master of Science in Health Science and the Master of Public Administration degrees are also offered. In addition, students can earn the Certificate of Advanced Graduate Study in the Program of Advanced Literary Study.

The Doctor of Philosophy Degree is available in biology, chemistry, economics, mathematics, physics, psychology, and sociology.

Several degree options are offered in the interdisciplinary areas of law, policy, and society; clinical and forensic chemistry; sociology or social anthropology; and education.

GENERAL REGULATIONS

The general regulations of the graduate school which follow are minimal requirements shared by the several degree programs. The student is advised to consult the appropriate departmental section for a statement of additional requirements in specific programs.

Application

Completed applications, recommendation forms, and complete official transcripts should be sent directly to the appropriate academic department. Applicants should make the necessary arrangements where required to have official reports of the Graduate Record Examinations and the Miller Analogies Test forwarded to the office of the Graduate School of Arts and Sciences. (Students interested in Forensic or Clinical Chemistry should direct applications to the Graduate School of Pharmacy and Allied Health Professions.)

Prospective students should consult the departmental sections for individual program deadlines for application. While the deadlines vary, and exceptions are occasionally made, necessary supporting documents must be on file with the departmental office at least eight weeks before the date of registration for the quarter in which the student wishes to begin his or her graduate work. However, students desiring assistantships should be aware that priority in these awards is generally given to applications submitted before March 15. Again, departments may have earlier or later deadlines. Please refer to the appropriate departmental section for complete information.

All applicants to the Graduate School are strongly urged to take both the

aptitude and advanced portions of the Graduate Record Examination. These tests are presently required by the departments of biology, English, history, and psychology. The Psychology Department also requires that the results of the Miller Analogies Test be submitted. The Sociology/Anthropology Department requires either the aptitude test scores (verbal, quantitative, and analytical) on the Graduate Record Examination or the Miller Analogies Test scores.

Applications for the Graduate Record Examination can be obtained by writing to:

Educational Testing Service
Box 955
Princeton, New Jersey 08540

At least two letters of recommendation are required by all departments—biology, math, political science, psychology, and sociology/anthropology require three letters. Candidates for financial awards should indicate their candidacy to those supplying references.

Though candidates for admission to Arts and Sciences graduate programs apply through the individual programs, the final decision concerning admissions is made by the Office of the Dean of the College of Arts and Sciences.

International Student Application

International students are responsible for submitting all supporting materials required by the department, as listed above and in the specific departmental section. In addition, each student is required to have a Declaration and Certification of Finances (DCF) form, as well as evidence of English proficiency on file with the Graduate School office at least ten weeks before the date of registration for the quarter in which the student expects to begin a scholastic program.

Evidence of English proficiency may consist of (1) satisfactory results on the Test of English as a Foreign Language (TOEFL), or (2) proof of a minimum of four years of study culminating in the receipt of a degree in an undergraduate institution abroad where the medium of instruction is English, or (3) proof of completion of a degree program at an American college or university.

Applications for the TOEFL may be obtained by writing to:

Educational Testing Service
Box 899
Princeton, New Jersey, 08540

Admission

To be enrolled for graduate work, an applicant must submit a complete official transcript, indicating the award of a bachelor's degree from a recognized institution, and provide evidence of being able to pursue creditably a program of graduate study in the chosen field. Acceptance to the School is granted upon recommendation of the departmental graduate committee after a review of the completed application.

In addition to the above, international students must have submitted evidence of English proficiency and financial support as outlined in the preceding section. Those who have not submitted such certification may not be granted a visa and will not be permitted to register.

Student Classification

Regular Student Those students who are admitted to a degree program.

Provisional Student Students whose records do not qualify them for acceptance as regular students. Provisional students must obtain a B (3.0) average in the first twelve quarter hours of study or meet specifically delineated departmental requirements to qualify for acceptance to a degree program.

Special Student Students with a bachelor's degree who are not matriculated in a degree program. All those interested in this status should inquire with the Graduate School office regarding application procedures and deadlines. Acceptance as a special student is in no way related to admission to a departmental degree program. However, those special students subsequently admitted to a degree program may petition through their departments to the Director of the Graduate School to apply the first twelve quarter hours of credit earned as special students toward degree requirements. Special students are expected to maintain a B (3.0) average in the first twelve quarter hours of study.

Doctoral Student Students admitted to a doctoral program.

Formal Doctoral Degree Candidate Doctoral students who have completed 40 quarter hours of acceptable graduate work, have passed the departmental qualifying examination, and have been certified by the Graduate School of Arts and Sciences.

Registration

Students must register within the dates and times listed on the school calendar. The place of registration will be announced quarterly. Students who fail to register will not earn credit or a grade for the course(s) in question.

Residence

All work for advanced degrees must be registered for and completed at the University, unless approval has been obtained from the Director of the Graduate School for work taken elsewhere. Procedures for obtaining such approval are described in the section of this bulletin on transfer credit.

Programs of Study

The study load for full-time students is usually three to four courses per quarter. Part-time students are not permitted to enroll in more than two courses per quarter without formal approval of the departmental chairperson or a designate. Courses in most fields are offered both in the afternoon and evening.

Grading System

The student's performance in graduate courses will be graded according to the following numerical equivalents:

A (4.0), A– (3.667)
These grades are given to those students whose performance in the course has been of very high graduate caliber.

B+ (3.333), B (3.0), B– (2.667)
These grades are given to those students whose performance in the course has been at a satisfactory level.

C+ (2.333), C (2.0), C– (1.667)
These grades are given to those students whose performance in the course is not at the level expected in graduate work.

F (0)
This grade is given to those students whose performance in the course is unsatisfactory.

In addition, the following letter designations are used:

I Incomplete without quality designation.
This grade may be given to those students who fail to complete the work of the course.

L Audit without credit.

S Satisfactory without quality designation.

U Unsatisfactory without quality designation.

W Withdrawal after the fifth week of classes.

The I grade will be changed to a letter grade when the deficiency which led to the I is corrected to the satisfaction of and in the manner prescribed by the instructor in the course, or, in the instructor's absence, by the chairperson of the department in which the grade is given. The period for clearing such a grade will be restricted to one calendar year from the date of its first being recorded on the student's permanent record.

Students who wish to audit a course must indicate this preference at registration. While no credit will be given for an audit, audits do appear on the student's transcript. Registration changes from an audit to a graded status in a course may not be made after the first day of classes.

Individual faculty members may choose not to use the plus and minus designations. If they elect to use the whole letters only, they must announce this to the class at the beginning of the quarter.

Class Hours and Credits

All credits are entered as quarter hours. A quarter hour of credit is equivalent to three-fourths of a semester hour of credit.

Continuity of Program

Students are expected to maintain continuous progress toward their intended

degrees. Any student who does not attend Northeastern for a period of one year may be required to apply for readmission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office or at the Suburban Campus Office. Withdrawals may be made through the ninth week of the quarter. However, withdrawals which are made after the fifth week of the quarter will be recorded with a "W" on the student's transcript.

Students will be withdrawn as of the date on which the form is received by the Registrar's Office. Ceasing to attend a class, or simply notifying the instructor of intention to withdraw, does not constitute an official withdrawal.

Changes in Requirements

The continuing development of the Graduate School forces frequent revision of curricula. When no hardship is imposed on the student because of changes, and when the facilities of the school permit, the student is expected to meet the requirements of the most recent bulletin. However, if doing so does impose a substantial hardship, the requirements in the bulletin of the year in which the student matriculated will be applicable.

Application for the Diploma

Application for the diploma is made by filing a commencement card with the Registrar's Office. Even though all other degree requirements may have been met, the commencement card must be filed on or before the applicable date listed in the calendar in order to assure that the degree will be conferred in the desired year. It is, of course, the student's responsibility to make sure that degree requirements have been met.

THE MASTER'S DEGREE

Academic Requirements

A candidate for the master's degree must complete a minimum of 40 quarter hours of graduate level course work and such other study as may be required by the department in which the student is registered.

To qualify for the degree, a final average of 3.0, equivalent to a grade of B, must be obtained. This average will be calculated quarterly by the Graduate School according to the grading system as specified on page 22, and will exclude any transfer credits or repeated courses.

Not more than six quarter hours of repeated courses or additional courses may be allowed in order to satisfy the requirements for the degree.

Within the above limitations, a required course for which a grade of F is received must be repeated with a grade of C or better, and may be repeated only once. Similarly, a student may elect to repeat a required course in which a C has been received. If a grade of F is received in an elective course, that course may

be repeated once to obtain a grade of C or better, or another elective course may be substituted for it.

Comprehensive Examination

A final written or oral comprehensive examination is required in some programs. This examination will be given by the department concerned at least two weeks before the commencement at which the degree is expected.

Thesis

Theses are required in some programs and should demonstrate the individual's capacity to execute independent work based on original material.

Theses must be approved by the departmental graduate committee, and, in cases where a grade is required, must receive a grade of B (3.0) or better to be accepted.

Language Requirement

An examination to show evidence of ability in one or more foreign languages is required in some graduate programs. This knowledge is established by an examination which will be administered by the appropriate department at least twice yearly.

Transfer Credit

Students should petition in writing, through their departments to the Director of the Graduate School of Arts and Sciences for all transfer credit. A copy of an official transcript should be attached to the petition. A maximum of 12 quarter hours of credit obtained at another institution may be accepted toward the master's degree, provided that the credits transferred consist of A or B grades in graduate-level courses, are in the candidate's field, have been earned at a recognized institution, and have not been used toward any other degree. Transfer credit grades may not be used for the purpose of obtaining the academic average necessary for completion of the degree requirements.

Time Limitation

Course credits earned in the program of graduate study, or accepted by transfer, are valid for a maximum of seven years unless an extension is granted by the Director of the Graduate School of Arts and Sciences. Students should petition, in writing, through their departments to the Director of the Graduate School for such extensions.

THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy degree is awarded to candidates who give evidence of high attainment and research ability in their major fields. Specific degree requirements are administered by a committee in charge of the degree

program. This committee may be a departmental graduate committee or the committee of the Graduate School, depending upon the nature of the program. It is the responsibility of the chairperson of the committee to certify to the Gradute School office the completion of each requirement for each candidate.

Admission

Each degree program has an established admission procedure for students starting their doctoral work at Northeastern University. Please consult the appropriate departmental section for further details.

Residence Requirement

A candidate for the Doctor of Philosophy degree must spend the equivalent of at least one academic year in residence at the University as a full-time graduate student. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Degree Candidacy

Formal degree candidacy is established when students have completed forty quarter hours of acceptable graduate work, where applicable, have passed the qualifying examination, and in all cases have been certified by the Graduate School of Arts and Sciences.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of each degree program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate.

Course Requirements

The minimum course requirement of 40 quarter hours constitutes the same work normally required for a master's degree. Course requirements beyond this in each doctoral program are specified by the committee in charge of the doctoral program.

Dissertation

Each doctoral student must complete a dissertation which embodies the results of extended research and makes an original contribution to the field. This work should give evidence of the candidate's ability to carry out independent investigation and interpret in a logical manner the results of the research. The method of approval of the dissertation is established by the committee in charge of the degree program.

Language Requirement

The foreign language requirement is established by the committee in charge of each degree program.

Final Oral Examination

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the dissertation. Other fields may be included if recommended by the examining committee.

This examination will be taken after completion of all other degree requirements and must be held at least two weeks prior to the commencement at which the degree is to be awarded.

Transfer Credit

Students should petition in writing, through their departments to the Director of the Graduate School of Arts and Sciences for all transfer credit. A copy of an official transcript should be attached to the petition.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of degree requirements.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officers. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program and certified by the Graduate School of Arts and Sciences. Students must be registered for dissertation during the quarter in which they take the final oral examination.

INTERDISCIPLINARY PROGRAMS

Some graduate students may wish to pursue doctoral programs which involve substantial work in two or more departments. To meet this need, an interdisciplinary program may be established which corresponds in scope and depth to doctoral standards, but does not agree exactly with the individual departmental regulations. For such possibilities, the option discussed below is available.

Admission

Application for admission to interdisciplinary doctoral study consists of the submission of a carefully thought-out written proposal describing the areas of proposed study and research, as well as the qualifying and comprehensive examination system to be used. The proposal may be a part of the initial application for admission to graduate study at Northeastern University, or it may be

submitted by a graduate student already enrolled. In either case, the admission materials should be prepared in consultation with an academic adviser. The proposal may be directed to a doctoral degree-granting department or to the Director of the Graduate School, who forwards it to the appropriate department. In either case, admission to interdisciplinary doctoral study requires favorable recommendation by the sponsoring doctoral degree-granting department and approval by authorized representatives of the graduate study committees of the departments appropriate to the disciplines covered by the applicant's proposal. The sponsoring department becomes the student's registration base.

Formation of Interdisciplinary Committee

A student who has been accepted for interdisciplinary study must obtain the consent of an adviser who will direct the doctoral dissertation. This adviser, who may or may not be a member of the registration department, will be chairperson of the interdisciplinary committee for this student. A second member will be appointed from the registration department by its chairperson. These two members will obtain one or more additional members or request the Director of the Graduate School to do so. At least two departments must be represented on the committee, and a majority of the committee must come from doctoral degree-granting departments. The chairperson of the registration department will notify the Director of the Graduate School of the membership of the committees as soon as arrangements are complete.

Duties of Interdisciplinary Committee

A member of the interdisciplinary committee who is also a member of the registration department will serve as the registration officer to approve the course registration for the student. A copy of the approved course registration must also be filed with the other committee members and with the graduate study committee of the registration department.

The interdisciplinary committee will be responsible for the administration of the qualifying examination, language examination, approval of the dissertation, and comprehensive examination. This committee must also certify to the registration department the completion of the requirements for the award of the doctoral degree. The interdisciplinary committee is also responsible for a periodic report to the registration department concerning the student's progress and must attain approval from that department for any changes in the approved program.

The interdisciplinary committee must assure that the student's program represents standards comparable to those of the registration department and that the program is not so broad that it has inadequate depth in any area.

The student's program may be reviewed at any time by the Director of the Graduate School to determine whether objectives of the program are being met.

financial information

FINANCIAL OBLIGATIONS

Tuition

Master's Degree Candidates

The tuition rate for 1982–83 is $135 per quarter hour of credit.

Doctoral Candidates

Tuition for full-time doctoral candidates in 1982–1983 is $135 per quarter hour of credit. Doctoral candidates actively utilizing the resources of the University in their Ph.D. dissertation are charged an additional $600 per quarter for the first three quarters of dissertation work. Those doctoral candidates registered for dissertation work performed off-campus are, on the recommendation of their departments, charged an additional $200 per quarter for the first three quarters of dissertation work. Those doctoral candidates who are no longer actively utilizing University resources are, on the recommendation of their departments, charged a continuation fee of $50 per quarter.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University.

Fees

A nonrefundable application fee of $25 is charged to all students applying for the first time to the Graduate School at Northeastern. There is an additional fee of $100 charged to new graduate international students who are not permanent residents. This fee, which covers the entire duration of the students' graduate programs, is payable upon their acceptance at Northeastern.

Other fees include a charge of $50 for late payment of tuition, a $10 fee for a deferred payment arrangement with the Bursar's Office, and a $25 mandatory commencement fee for all degree candidates. The commencement fee is payable before commencement by the applicable date listed on the academic calendar.

In addition, full-time students are charged $12.50 per quarter for services available in the Student Center. The fee for teaching assistants and research fellows for similar services is $6.25 each quarter. All part-time students on the Huntington Avenue campus are charged $.75 per quarter.

All full-time students must also pay a nonrefundable University health service fee of $200 each year. This fee provides Blue Cross/Blue Shield coverage and entitles the student to the medical care furnished by the University Health Services. If students have their own medical insurance or are covered under an-

other plan, they may deduct $100 from their health services bill and pay only the difference, and they must complete a Blue Cross/Blue Shield waiver form obtained at and returned to the Bursar's Office. As part of their tuition scholarship, teaching assistants and research fellows receive remission of health services fees. Tuition fellows, however, are expected to pay health-services fees themselves. Part-time or continuation-fee students must purchase health insurance independently.

All financial obligations to the University must be discharged by graduation.

Tuition rates and fees are subject to revision by the President and the Board of Trustees at any time.

Refunds

Tuition refunds will be granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Amount of Refund

Official Withdrawal Filed Within	Percentage of Tuition
First week of quarter	100
Second week of quarter	75
Third week of quarter	50
Fourth week of quarter	25

FINANCIAL AID

The Office of Financial Aid offers several types of assistance to graduate students. All awards are based on financial need. Since the majority of these awards are sponsored by the Federal Government, the amount of aid granted is dependent upon the amount of funds allocated to Northeastern University each year.

In order to meet application deadlines for financial aid, students may have to apply for aid before they have been offered admission to the Graduate School. However, only those students who are accepted will be reviewed for financial aid. In addition, the University only awards financial aid to students who are U.S. citizens and permanent residents of the United States. Students who are studying in the United States on student visas are not eligible for federal assistance.

Northeastern University is a participant in the Graduate and Professional School Financial Aid Service (GAPSFAS). All applicants for financial aid must file a GAPSFAS form in order to be considered. All sections of the GAPSFAS form, including the parents' section, must be completed and sent to the GAPSFAS, Box 2614, Princeton, New Jersey 08540. In addition to the GAPSFAS form, Northeastern also requires a Graduate School Financial Aid Application and a Financial Aid Transcript. All of these forms are available at the Office of Financial Aid, 254 Richards Hall.

The following types of assistance are administered by the Office of Financial Aid:

National Direct Student Loan

This program is available to full-time graduate students who show a high level of financial need. Graduate students may borrow up to $12,000 during the course of their entire educational careers. Repayment and interest do not begin until six months after the student ceases to carry at least a half-time academic load. Repayment may be extended over a ten year period with an interest rate of five percent per annum. No payments are required for up to three years while a borrower is serving in the Armed Forces, Peace Corp, VISTA, or while working as a full-time volunteer for a tax-exempt charitable organization.

College Work-Study Program

This program is available to full-time graduate students who show financial need. It is designed to give students an opportunity to earn as much as $5 per hour working in jobs on or off campus in public or private nonprofit organizations. This program is administered solely by the Office of Financial Aid and should not be confused with the University's Cooperative Education Program.

Guaranteed Student Loan Program

Under this program, students whose families have adjusted gross incomes under $30,000 may borrow money for educational expenses from banks or other private lending institutions. Students whose families have adjusted gross incomes which exceed $30,000 may also borrow if they can show financial need in accordance with guidelines established by the U.S. Department of Education. Students must be enrolled on at least a half-time basis to be eligible for these loans. Terms and conditions of these loans vary from state to state. Repayment, which begins six months after the student ceases to carry at least a half-time load, may be extended for as long as ten years. The interest rate during repayment is nine percent per annum. No payments are required for up to three years while the borrower is serving in the Armed Forces, Peace Corps, VISTA, or while working as a full-time volunteer for a tax-exempt charitable organization. Information and applications are available from lenders, state guarantee agencies, and regional offices of the U.S. Department of Education. Massachusetts residents may contact the Office of Financial Aid for more information.

SCHOLARSHIPS

Northeastern University Fellowships (NUF)

These fellowships are to assist a limited number of students accepted for full-time study in the Graduate Schools of the University. The awards are made to students who demonstrate superior academic achievement and are competitive within each graduate school. Stipends cover tuition and fees. Applications may be obtained from the Graduate School Office.

Martin Luther King, Jr., Scholarship

A limited number of full-time Martin Luther King, Jr., Scholarships are available. These Scholarships pay the recipient's full tuition and fees during the course of satisfactory graduate work. Further information and applications are available at the African-American Institute, Northeastern University, 40 Leon Street, Boston, Massachusetts 02115.

Robert A. Feer Scholarship

This scholarship is awarded yearly to the outstanding candidate for the Master of Arts degree in History. The scholarship was established in memory of Professor Robert A. Feer who was a member of the Department of History from 1963 to 1970.

Please Note: This information is current as of the date of publication. All federal programs are subject to change. Please check with the Office of Financial Aid to determine the status of Financial Aid programs at the time you plan to enroll.

ASSISTANTSHIPS

Northeastern University has available a limited number of assistantships for full-time students who are working toward the master's or doctor's degree. Candidacy for these awards may be established by completing the appropriate section on the application for admission. Those students already enrolled should consult their departmental advisers.

Appointments to assistantships are ordinarily announced no later than April 15 for the following academic year or summer. Appointments are for a maximum of three quarters and are not automatically renewed. Students who hold assistantships are expected to devote full time to their studies and the duties of the award. Applicants should note that 39-week assistantships provide tuition remission for the calendar year.

Teaching Assistantships

In all departments a limited number of teaching assistantships are available to graduate students, offering them the opportunity to receive a tuition scholarship. A stipend is also given with the award in return for academic assistance in the department in areas directly related to the teaching function. Holders of such awards are expected to devote half their time to the duties of the award and the balance to course work.

Graduate Administrative Assistantships

Some departments offer graduate administrative assistantships which provide students the opportunity to receive a tuition scholarship. A stipend is also given with the award in return for half time spent in assisting the department with nonteaching, administrative duties. These assistantships are available on a limited basis.

Research Assistantships

A number of departments offer a limited number of research assistantships, offering students the opportunity to receive a tuition scholarship. A stipend is also given in return for research done in the department. Certain of these grants require half-time work on research in the department, with the remaining time devoted to course work. Others provide for full-time work on research used for a thesis or dissertation.

Northeastern University Tuition Assistantship (NUTA)

A limited number of tuition assistantships are available offering remission of tuition to full-time students assisting ten hours a week in the administrative work of the department. These awards are normally given to students in the first year of graduate work. Students should note that the value of the tuition received via this type of assistantship is taxable. Applications may be obtained from the Graduate School Office.

Residence Hall Staff Positions

A limited number of residence staff positions in housing facilities are available each year. Appointments carry a minimum compensation of room and board. Further information may be obtained from the Office of University Housing, 104–106 Ell Building.

ACCEPTANCE CONDITIONS

Northeastern University, a member of the Council of Graduate Schools of the United States, subscribes to the following resolution of the Council:

Acceptance of an offer of financial aid (such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by an actual or prospective graduate student completes an agreement which both student and graduate school expect to honor. In those instances in which the student accepts the offer before April 15 and subsequently desires to withdraw, the student may submit in writing a resignation of the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment has been made. Similarly, an offer by an institution after April 15 is conditional on presentation by the student of the written release from any previously accepted offer.

OUTSIDE GRANTS

Frequently, the Dean's Office receives announcements of available funds for research sponsored by organizations outside the University, such as the National Science Foundation and the National Endowment for the Humanities. For further information contact the Dean's Office, 400 Meserve Hall, 437-3980.

The federal aid programs listed above are available to citizens and permanent residents of the United States. All financial aid is available on a limited basis.

fields of study

The departmental sections that follow list courses available to a student during the typical period of attendance required to obtain a degree. The quarter in which a specific course will be offered will be found in the course announcement made available in May for the summer quarter and in June for the following academic year.

biology

Professors

David C. Wharton, Ph.D., Pennsylvania State University, Chairman
Francis D. Crisley, Ph.D., University of Pittsburgh
Janis Z. Gabliks, D.D.S., Baltic University; Ph.D., Rutgers University
M. Patricia Morse, Ph.D., University of New Hampshire
Nathan W. Riser, Ph.D., Stanford University, Director, Marine Science and Maritime Studies Center
Fred A. Rosenberg, Ph.D., Rutgers University
Ernest Ruber, Ph.D., Rutgers University

Associate Professors

Kostia Bergman, Ph.D., California Institute of Technology
Charles H. Ellis, Jr., Ph.D., Johns Hopkins University
Gwilym Jones, Ph.D., Indiana State University
Helen Lambert, Ph.D., University of New Hampshire
Charles A. Meszoely, Ph.D., Boston University
Joseph V. Pearincott, Ph.D., Fordham University
Daniel Scheirer, Ph.D., Pennsylvania State University
Phyllis R. Strauss, Ph.D., Rockefeller University
Henry O. Werntz, Ph.D., Yale University

Assistant Professors

Joseph L. Ayers, Jr., Ph.D., University of California, Santa Cruz
Donald P. Cheney, Ph.D., University of South Florida
Duncan Munro, Ph.D., University of Michigan
Michael S. Strauss, Ph.D., University of California, Irvine

GRADUATE PROGRAM

Procedures for Admission

All application forms and catalogs should be requested from the Biology Department office. Requests for information about programs should be directed to the program Graduate Director. There are three programs in Biology: Master of Science in Biology (full- or part-time); Master of Science in Health Science (full- or part-time); and Doctor of Philosophy (full-time only).

Financial Aid

General Policies: All full-time students enrolled in the Biology Department's master's or doctoral degree programs are eligible to be considered for financial aid. A full-time master's student is defined as one enrolled in courses worth approximately seven graduate credits per quarter and, in any case, one who will complete 20 graduate credits within one year.

As noted under *General Regulations of the Graduate School of Arts and Sci-*

ences, all students who hold assistantships and research fellowships are expected to devote full-time to their studies and the duties of the award.

As a general department policy, a master's degree student is eligible for not more than two years of financial aid, and a doctoral student is not eligible for more than three years. After the first year, reappointments are considered on the basis of academic performance, and on professor and student evaluatons from the assigned classes.

Application for Financial Aid: For consideration for financial aid, eligible students of any departmental program must include in their application materials the Graduate Record Examination scores, including the Advanced Test Scores in Biology. Awards are made on the basis of academic record, GRE scores, consideration of the awards available, and the candidate's experience and skills for teaching or research in the various fields. *Financial aid is available on a limited basis, therefore early application is desirable.*

THE MASTER OF SCIENCE IN BIOLOGY

The Master of Science in Biology is a research-oriented degree which is offered on a part-time or full-time basis. The Department offers opportunity for concentrations both in course work and research in areas of study that include animal physiology, biochemistry, botany, cell biology, ecology, marine biology, microbiology, and zoology.

Admission

In addition to the requirements of the Graduate School of Arts and Sciences, applicants should have a background which includes one year each of organic chemistry, physics, and mathematics, and courses equivalent to the six one-quarter courses (four q.h. each) of the biology undergraduate core curriculum (18.131–18.136). Students with deficiencies should remove them during the first twenty quarter-hours of graduate work.

Transcripts of academic work and three letters of recommendation are required. Graduate Record Examination (GRE) scores, including the Advanced Test in Biology, must be submitted. Admission decisions are made by the Biology Department's Subcommittee on Admissions.

Provisional and Regular Status

If a student has less than an optimum undergraduate average or has low GRE scores, the Graduate Admissions Subcommittee may admit the student with a provisional status. Under normal circumstances a student in this category is not eligible for financial aid. A provisional student must have a B average at the end of twelve quarter hours of graduate credit. At that time he/she is given regular status (if maintaining a B average) or terminated from the program. A regular student is expected to maintain a B average but does not come under review at the end of the twelve hours and is eligible for all forms of financial aid.

Deficiencies

Deficiencies can be filled by 1) taking course equivalents in the College of Arts

and Sciences; 2) taking University College (evening) courses; 3) taking equivalent undergraduate lecture-laboratory courses at another four-year-institution. Neither of the latter two will receive graduate credit; however, graduate credit may be awarded under the first option if the courses taken are the graduate equivalent as described in the following section.

Equivalents in University College of Arts and Sciences Courses

Arts and Sciences		*University College*
18.134	Environmental and Population Biology	18.461, 18.462, and 18.463 (two of three)
18.135	Genetics and Developmental Biology	18.457, 18.458, and 18.459
18.136	Cell Biology	18.431, 18.432 and 18.433

It is strongly recommended that students take the regular Northeastern University day undergraduate courses and/or their 2 q.h. graduate credit equivalents (listed below) to remedy their deficiencies:

18.834	Environmental and Population Biology	(2 q.h.)
18.835	Genetics and Developmental Biology	(2 q.h.)
18.936	Cell Biology	(2 q.h.)

Academic Requirements

Forty hours of academic work are required to complete the M.S. in Biology. Of this, twenty hours must be work in Biology Department graduate courses (18.200, 18.800, 18.900 courses, excluding 18.980, 18.990, 18.991, and 18.994). In addition, four hours of seminars (18.980) and six hours of research (18.981 M.S. thesis or 18.994 M.S. Literature Dissertation) are required. Of the remaining ten hours required, four may be additional research credits (18.990, 18.991, 18.994) or all may be Biology Department graduate courses (excluding 18.980) or approved courses from other Departments within the University. Any transfer credit is included within these ten hours.

Note, in any case, a maximum of ten hours of research courses is applicable to the M.S. degree which must include a minimum of six hours of 18.991 or 18.994.

A cumulative average of 3.0 for all graduate work is required for the award of the M.S. degree. All regulations of the Graduate School of Arts and Sciences apply with regard to maintenance of academic standing.

Research

Either six hours of M.S. thesis (18.991) or six hours of M.S. Literature Dissertation (18.994), both of which culminate in a written report, are required for the M.S. in Biology.

M.S. Thesis—The M.S. thesis involves a program of laboratory or field research leading to the writing and oral defense of the thesis itself. The candidate works under the direction of a member of the graduate faculty and a committee of two other biology graduate faculty members.

M.S. Literature Dissertation—The M.S. Literature Dissertation involves a program of extensive literature research leading to a comprehensive written review of a sig-

nificant biological problem and an oral examination. This study is undertaken with a member of the biology graduate faculty and a committee of two other biology graduate faculty.

MASTER OF SCIENCE IN HEALTH SCIENCES

The M.S.H.S. degree is offered to provide a more flexible set of options for students interested in Health Sciences. Students may enroll on a full- or part-time basis. The specific curriculum of studies by M.S.H.S. degree students is determined by consultation with the Graduate Director of the Program and/or adviser within the general guidelines specified under Academic Requirements below.

Admission

In addition to the requirements of the Graduate School of Arts and Sciences, applicants should have a background which includes one year each of organic chemistry, physics, and mathematics, and courses equivalent to the six one-quarter courses (four q.h. each) of the biology undergraduate core curriculum (18.131–18.136). Students with deficiencies should remove them during the first twenty hours of graduate work. In the M.S.H.S. program, some flexibility is allowed in the way in which these deficiencies may be removed (or waived), with the approval of the Graduate Director of the program, and the Department's Graduate Committee.

Candidates are required to submit transcripts of academic work and three letters of recommendation.

Academic Requirements

For the M.S.H.S., the candidate must complete forty hours of academic work. Of this, twenty hours must be course work in Biology Department graduate courses (18.200, 18.800, 18.900 excluding 18.980, 18.990, 18.991, 18.994). In addition, four seminars (18.980) are required. Two of these seminars, with prior approval of the Graduate Director of the Program, may be graduate seminars offered by other departments in the University. The remaining sixteen hours of graduate credit may be Biology Department graduate courses, up to six hours of research courses (including 18.992), or approved courses from other departments in the University. A maximum of twelve hours of transfer credit is included within these sixteen hours.

A cumulative average of 3.0 for all graduate work is required for award of the M.S.H.S. The regulations of the Graduate School apply with regard to maintenance of academic standing.

Final Comprehensive Exam

In the final year of graduate study, the M.S.H.S. candidate must successfully complete a written final comprehensive examination in a major and minor area, unless the research option (described below) is exercised. This examination is designed to test the candidate's proficiency in the areas of study. If not successfully completed, one reexamination is permitted. Candidates should notify the program director six months before they intend to take the examination.

Research Option

A research option (M.S. thesis or Literature Dissertation) is available and all rules

as stated in the M.S. Biology section apply. A successful oral defense of thesis or literature dissertation may substitute for the final comprehensive exam.

THE DOCTOR OF PHILOSOPHY

Admission

Only appliants who have a master's degree or its equivalent at entry may be considered for direct admission to the doctoral program. Those who do not may be considered only after admission to the master's program and after satisfactory completion of 30 hours of graduate study, which must include completion of some research. All students must submit transcripts, three letters of reference, and GRE scores, including the Advanced Test in Biology. In addition, a student must have a written agreement on the part of a graduate faculty member who will serve as the thesis adviser.

Residence Requirement

After admittance to the doctoral program, the student may satisfy the residence requirement by one year of full-time graduate work or by two years of half-time graduate work.

Qualifying Examination

The qualifying examination is an oral examination intended to evaluate the student's knowledge of the basic principles inherent in the various areas of biology as represented in the core curriculum and to ascertain the student's readiness to continue in the research program in the area chosen. Students *must* take the qualifying exam by the end of three quarters at Northeastern University.

Academic Requirement

Course requirements for Ph.D. candidates are variable, depending on recommendations of the major adviser and examination committees, but in any event, a cumulative average of 3.0 for all graduate work is required.

Teaching Requirement

A Ph.D. candidate is required to spend one year as a Teaching Assistant in the Department. If the candidate wishes this requirement to be waived, he or she must petition the Department Graduate Committee and provide evidence of equivalent teaching experience.

Language Requirement

Candidates must establish evidence of an ability to read and translate biological literature in two foreign languages. The primary languages for Biology are French, German, and Russian. Students will be expected to choose from these languages for their examinations; however, another language may be substituted where there is significant literature in the area of interest.

One of the language requirements may be fulfilled by completion of two courses in the general principles of statistics, biometry, and/or computer programming.

Ph.D. Comprehensive Examination

The comprehensive examination may be taken by the Ph.D. candidate after passing at least one of the language requirements or its equivalent. The questions on the examination are designed to test whether the student's knowledge of concepts and methods of the area are sufficiently comprehensive and profound to enable him/her to enter on a career of fruitful teaching and research. The examination in the major field will delineate the candidate's potential to teach advanced courses, while the minor examination will show competency to teach undergraduate courses in that field.

Thesis

The thesis is the most important part of the Ph.D. degree and must be an original and independent scientific study. The thesis adviser and student will work closely to evolve the problem and arrange for a Ph.D. thesis committee. The minimum number of members for a Ph.D. committee is five. One member must be an acknowledged expert from outside the University.

SPECIAL-STUDENT STATUS

Special students are not matriculated in a degree program, and acceptance as a special student is not related to admission into a departmental degree program. However, those special students who are subsequently admitted into a degree program may petition through the M.S.H.S. Graduate Director to the Director of the Graduate School to apply the *first twelve* hours of graduate credit earned as a special student toward degree requirements. Special students are expected to maintain a B average in the first twelve quarter hours of study. The M.S.H.S. Graduate Director is the overseer for special students.

Further information on admission procedures and standards can be obtained from the Graduate School of Arts and Sciences or the M.S.H.S. Graduate Director.

INTERDISCIPLINARY PROGRAMS

Admission

Application and credentials for admission to interdisciplinary programs involving the Biology Department, where this department is clearly the department of registry, as described under "General Regulations," should be submitted as described under the heading of "Admission" in the section "The Doctor of Philosophy" for biology. The interdisciplinary commitee will consist of at least five members. The composition of this committee will be determined by mutual consent between the departments involved, but will have at least three members from the Biology Department if the dissertation adviser is from this Department. Upon admission, suitable interdisciplinary course requirements will be determined by the interdisciplinary committee.

Qualifying Examination

Students accepted into the program will normally be expected to complete the qualifying examination by the end of three quarters at Northeastern University. At

least five areas of study will be covered by the qualifying examination, which must include at least three oral examinations chosen by the candidate from the following areas: biochemistry, botany, ecology, genetics, microbiology, physiology, and zoology. The remaining components of the examination will be specified and evaluated by the other participating department. With the exceptions of the procedures for admission and examinations for qualification, the remaining requirements and procedures are as specified under "The Doctor of Philosophy" for biology.

DESCRIPTION OF COURSES

18.804 Lower Invertebrates (4 q.h.)
Taxonomy, morphology, embryology, and life histories of acoelomate phyla (Marine Science and Maritime Studies Center).

18.805 Coelomate Invertebrates (4 q.h.)
Biology of annelids, arthropods, molluscs, and echinoderms (Marine Science and Maritime Studies Center).

18.806 Malacology (4 q.h.)
Functional morphology, embryology, systematics, and ecology of the major groups of molluscs. *Prep. Invertebrate Zoology.*

18.808 Developmental Biology of Marine Invertebrates (4 q.h.)
Descriptive and experimental studies of embryonic and larval development of marine invertebrates. Laboratory work includes observation and experimentation using live material from a broad spectrum of invertebrate phyla (Marine Science and Maritime Studies Center).

18.809 General Helminthology (3 q.h.)
Morphology, life histories, and biology of helminths parasitic in animals.

18.810 Ichthyology (4 q.h.)
Natural history and systematics of fishes, with emphasis on marine species (Marine Science and Maritime Studies Center). *Prep. Comparative Anatomy* or *Vertebrate Zoology.*

18.813 Dynamics of Aquatic Ecology (3 q.h.)
Chemical, physical, and biotic features influencing coastal, lake, and stream communities. Lectures. *Prep. 18.134 or 18.834 or equivalent.*

18.815 River Ecology Laboratory (3 q.h.)
Two four-hour sessions per week (combined lecture and lab). Chemical determinations, measurement of primary and secondary production, organismal identification in flowing waters of different types.

18.816 Lake Ecology Laboratory (3 q.h.)
Two four-hour sessions per week (combined lecture and lab). Chemical determinations, measurement of primary and secondary production, organismal identification in lakes of different types.

18.818 Ecology of Salt Marshes (3 q.h.)
Survey of fauna and flora, environmental factors affecting them, and current biological and social problems associated with salt marshes. This course will meet for two lectures of one and one half hours each, and one full day of laboratory for six weeks during the

summer quarter. *Prep. 18.134 or 18.834 or equivalent.*

18.819 Ecology of Rocky Shores (4 q.h.)
Examination of current ecological concepts regarding rocky intertidal and subtidal communities. The influence of biotic and abiotic factors on the composition, distribution, and diversity of plant and animal species is emphasized.

18.823 Human Ecology (4 q.h.)
Human tolerances for natural and unnatural environmental factors and man's activities affecting these factors. Man, food, and population dynamics.

18.825 Plant Nutrition and Metabolism (4 q.h.)
Mineral nutrition, photosynthesis, metabolic pathways, and translocation in higher plants.

18.826 Plant Growth and Reproduction (4 q.h.)
Plant hormones, growth, development, and physiology of reproduction. *Prep. 18.825.*

18.830 Marine Algae (4 q.h.)
Systematics, life histories, and ecology of marine algae, with emphasis on the flora of the Gulf of Maine (Marine Science and Maritime Studies Center).

18.831 Plant Morphogenesis (4 q.h.)
The origin of form, experimentally controlled development, and external and internal factors that govern development of form. Plant tissue, organ, and cell culture techniques employed in the study of morphogenetic processes. *Prep. 18.237.*

18.834 Environmental and Population Biology (2 q.h.)
Physiochemical factors influencing and influenced by organisms. Interactions among individual organisms and among species. Students are expected to participate in lectures and laboratories given for 18.134. Individual work on specialized aspects of ecology is assigned. *Prep. One year of general biology, including plant and animal biology. Open only to graduate students completing deficiencies in entrance requirements.*

18.835 Genetics and Developmental Biology (2 q.h.)
Elaboration of the classic laws of heredity, including cytogenetics and chemical basis of heredity. Selected examples of the development of form and function. Students are expected to participate in lectures and laboratories given for 18.135 and are assigned extra individual work. *Prep. general biology. Open only to graduate students completing deficiencies in entrance requirements.*

18.836 Cardiovascular Physiology (3 q.h.)
Physiology of blood cells, anemia, polycythemia immunity, and allergy. Electrophysiology of the heart, cardiac cycle, EKG, hemodynamics, capillary dynamics, pulmonary circulation, cardiovascular reflexes, cardiac output, and venous return. Cardiac failure, coronary circulation, atherosclerosis, hypertension, cerebral circulation, circulatory shock.

18.837 Cardiovascular Physiology Laboratory (1 q.h.)
Three hours of laboratory study per week. *Prep. 18.836.*

18.838 Animal Nutrition (2 q.h.)
Detailed consideration of organic and inorganic nutritional requirements of humans and selected animals. Digestion, absorption, and metabolism of nutrient materials. Role of vitamins, minerals, and trace elements in metabolism. Variation in nutritional needs among normal individuals and in various physiologic and genetic pathologies. Evaluation of food

additives and of permissible levels of toxic materials in food. *Prep. Basic Biochemistry or consent of instructor.*

18.839 Principles of Systematics (2 q.h.)
Presentation of theories and techniques employed in systematics; rules according to the International Codes of Zoological and Botanical Nomenclature.

18.840 Osmotic and Ionic Regulation (2 q.h.)
Comparative physiology of regulation and transport of water and the principal solutes in animals. Principles and underlying mechanisms will be discussed, as well as examples selected from a variety of phyla. *Prep. Basic Physiology.*

18.841 Human Genetics (3 q.h.)
Application of basic genetic principles to the study of variability in man. Course focuses primarily on cytogenetics, biochemical genetics, monogenetic, and multifactorial inheritance and population genetics. Topics of special interest include sex determination and differentiation, early embryology, twinning, birth-defect etiology, prenatal diagnosis, and genetic counseling. *Prep. 18.135 or equivalent.*

18.843 Environmental Physiology (3 q.h.)
Study of the mechanisms for short-term and chronic adaptation to changes in environmental conditions. Consideration of physiological responses to high altitudes, diving, thermal environment, space travel, and biological clocks. Endothermic vertebrates are emphasized. For students with background in physiology. *Prep. Basic Animal Physiology or consent of instructor.*

18.844 Vertebrate Endocrinology (3 q.h.)
Principles of hormonal regulation of physiological processes in vertebrates, mechanisms of hormone action, neuroendocrine relationships.

18.847 Environmental Law (2 q.h.)
The scientific information required for implementation of the legal and political aspects of environmental management. The role of the scientist as an expert witness. Scientific and legal predictability. Analyses of suitable dynamic models and case law with the goal of improving the results of legal, political, and scientific decisions bearing upon remedial environmental management. *Prep. Biology core and first course in physiology, e.g., 18.252 and 18.253.*

18.852 Advanced Developmental Biology (3 q.h.)
Study of current concepts of animal and plant development at the molecular and physiological levels. Among topics of discussion are nucleic acid and protein synthesis in development, metabolic activation at fertilization, regulation of the eukaryotic genome, control of cell differentiation, and molecular communication between cells. Reading and interpretation of the primary literature is stressed. Three hours of lecture per week.

18.853 Advanced Develpmental Biology Laboratory (2 q.h.)
Analysis of the fundamental problems of development through experimental techniques. Culture of vertebrate and invertebrate embryos; microsurgical analysis of morphogenesis; biochemistry of development, cell-cell interactions; and organ and tissue culture are studied. Five hours of laboratory per week. *Prep. 18.852 or consent of the instructor.*

18.854 Cellular Aspects of Development (3 q.h.)
Study of phenomena of animal and plant development at the cellular level. Among discussion topics are cell-cell interaction in development, cell surface differentiation, differential

cell adhesion, genetic and epigenetic control of pattern formation, and ultrastructural aspects of fertilization and development. Reading and interpretation of the primary literature are stressed. Three hours of lecture per week.

18.857 Experimental Mammalian Physiology (4 q.h.)
Experimental study of the circulatory, respiratory, digestive, excretory, reproductive, nervous, and endocrine systems in mammals, with emphasis on laboratory procedures and surgical techniques used with living animals—chiefly, the rat. *Prep. Background in physiology, consent of the instructor.*

18.860 Cell Biophysics and Biochemistry (5 q.h.)
Biogenesis and ultrastructure of the cell considered together with the biophysical procedures and biochemical patterns used in the study of cellular and tissue components. Lecture only. *Prep. Organic Chemistry, General Biology, Biochemistry, and Cell Biology.*

18.862 Comparative Neurobiology (3 q.h.)
A cellular approach to structure and function in the nervous system. Topics to be covered include: neuronal anatomy, cellular properties of single neurons, synaptic transmission, integration in nerve cells, nerve networks, sensory systems, motor systems, sensory-motor integration, specification of neouronal connectivity, and the phylogeny of nervous systems. *Prep. General (Animal) Physiology.*

18.864 Neurophysiology Laboratory (2 q.h.)
Introduction to neurophysiological methods. *Prep. 18.862 (may be taken concurrently).*

18.869 Nervous Control of Homeostatic Functions (3 q.h.)
Lecture and discussion of the nervous control of ventilation, heart and vascular system, water and salt intake, feeding and body weight, energy metabolism, arousal, pain mechanisms, and factors affecting autonomic function. Emphasis on higher vertebrates. *Prep. Basic Animal Physiology.*

18.872 The Gastrointestinal Tract (3 q.h.)
A study of structure, function, and, where appropriate, the pathology of the gastrointestinal tract. A histological overview of the structure of all areas of the tract, including the liver and gallbladder, is followed by a functional analysis covering secretion, absorption, and bile formation and release. *Prep. Basic Animal Physiology or consent of instructor.*

18.873 Renal Physiology (2 q.h.)
An in-depth study of the mammalian kidney. Examination encompasses the structure of the kidney and its relationship to kidney function. Functional aspects are related to the mechanisms of ionic balance, water balance, and acid-base balance necessary for the maintenance of the total organism. The effects of hormones on the kidney and kidney hormones on the total organism are also covered. *Prep. Physiology, Cell Biology, or permission of instructor.*

18.890 Biology of Meiofauna (2 q.h.)
Systematics and ecology of marine interstitial fauna. *Prep. Invertebrate Zoology.*

18.903 Environmental Microbiology (4 q.h.)
The microbial environment and ecology of the cell. Interactions between microbial populations, stressing soil and fresh-water associations. *Prep. 18.220 or equivalent.*

18.906 Food Microbiology (3 q.h.)
Microbiology of food with emphasis on the pathogenic types and their interactions with

other groups indigenous to food. Food fermentations, food processing, and environmental factors influencing growth and development of microorganisms in food. *Prep. 18.220 or equivalent.*

18.908 Food Microbiology Laboratory (2 q.h.)
Detection, quantification, and isolation of microorganisms and their products of significance in food with emphasis on the pathogenic types. *Prep. 18.907 (may be taken concurrently).*

18.910 Microbial Genetics (3 q.h.)
The principles and practical application of the genetics of microorganisms. Genetic exchange in bacteria mediated by bacteriophage and plasmids is emphasized. Several eukaryotic systems are also discussed. *Prep. 18.220 or equivalent.*

18.911 Microbial Genetics Laboratory (2 q.h.)
The methods of genetics, including the isolation and mapping of mutants, will be applied to an original research problem in microbial physiology. *Prep. 18.910 (may be taken concurrently) and consent of instructor.*

18.912 Animal Virology (3 q.h.)
Physical and chemical properties of viruses, viral replication, genetics, cytopathology, and tumor viruses. Medical virology, including pathogenesis, clinical features, epidemiology, and immunization of the common viral diseases. *Prep. 18.220 or equivalent.*

18.913 Virology Laboratory (2 q.h.)
Cultivation and identification of viruses. Use of animals, eggs, and animal cell cultures for viral assays. *Prep. 18.912 (may be taken concurrently).*

18.916 Nonspecific Factors in Resistance (2 q.h.)
In contrast to 18.245 which deals with specific antigens inducing the formation of specific antibodies and/or cell-mediated responses, this course considers the impact of antigens on nonspecific responses, i.e., interferon production, complement action, phagocytic responses, macrophage action, properdin, etc. *Prep. 18.220 or equivalent.*

18.920 Industrial Microbiology (3 q.h.)
Microorganisms and methods employed in production of products of economic and medical importance, decomposition of wastes, and control of desirable and unwanted processes and biodeterioration. Fermentation processes emphasized. *Prep. 18.240 or equivalent or consent of instructor.*

18.921 Industrial Microbiology Laboratory (2 q.h.)
Laboratory and discussion seminar sessions devoted to the study of selected commercial processes.

18.936 Cell Physiology and Biochemistry (2 q.h.)
Basic chemical and physical processes of cells related to their fine structure; oxidative and intermediary metabolism; photosynthesis, membrane phenomena; movement; chemical and physical processes of prokaryotic and eukaryotic cells. Students are expected to participate in lectures and laboratories given for 18.136. Extra individual work is assigned. *Prep. General Biology, college physics, and organic chemistry. Only open to graduate students completing deficiencies in entrance requirements.*

18.940 Microbial Biochemstry (4 q.h.)
Study of enzymatic reactions, including their mechanism and regulation, involved in path-

ways of energy metabolism and biosynthesis by microorganisms. The mechanism of action and research use of antibiotics are discussed. *Prep. A term or more of biochemistry.*

18.980 Seminar (1 q.h.)
Various topics and newer developments in botany, microbiology, physiology, and zoology covered in depth. Student presentations are emphasized. To facilitate the planning of assignments, students are urged to contact the instructor during the quarter before the seminar is to be offered.

18.990 Special Topics in Biology (credit variable)
Special study of a selected topic under direction of a faculty member, preliminary to submission and approval of M.S. Thesis proposal or M.S. Literature Dissertation proposal. Topic and direction of study to be arranged with the faculty member supervising the study. *Credits convertible to M.S. Thesis or M.S. Dissertation.*

18.991 M.S. Thesis (credit variable)
Research methods of some special field and their application to a specific problem, under direction of a faculty member.

18.992 Special Investigations in Biology (credit variable)
Studies on a topic not directly related to research being pursued for a thesis or dissertation; may take the form of a special course.

18.993 Biological Electron Microscopy (4 q.h.)
Techniques of electron microscopy applied to biological materials. Specimen preparation, fixation, thin-sectioning, staining, operation of electron microscope, photographic techniques, interpretation of electron micrographs. Student seminars and project required. *Prep. Consent of the instructor.*

18.994 M.S. Literature Dissertation (credit variable)
An extensive literature research under the direction of a biology graduate faculty member leading to a comprehensive written review of a significant biological problem and an oral examination.

18.995 Ph.D. Dissertation
Original research in depth, representing a significant contribution of new biological knowledge, and a written dissertation thereon, under the supervision of a faculty member.

90.821 Biochemistry I (2 q.h.)
Description of the components of biochemistry, including the chemistry of carbohydrates, lipids, prostaglandins, steroid hormones, amino acids, polypeptides, proteins, purines, pyrimidines, nucleosides, and nucleic acids. Consideration of Henderson-Hasselbalch expression, buffers, and importance of pKa. *Prep. two quarters of Organic Chemistry.*

90.822 Biochemistry II (2 q.h.)
Discussion of enzymes, enzyme kinetics, and mechanisms of enzyme reactions. An introduction to the methods used for intermediary metabolism, bioenergetics, biological oxidation-reduction reactions, and the electron transport chain. A consideration is made of carbohydrate metabolism, including the citric acid cycle, the Embden Meyerhoff pathway, and the pentose phosphate pathway. Use of isotopes in biochemistry and the role of high-energy phosphate compounds are outlined. *Prep. 90.821.*

90.823 Biochemistry III (2 q.h.)
Lipid metabolism is presented, including the fatty acid cycle, the biosynthesis of fatty

acids, and the biological formation of the prostaglandins, cholesterol, and steroid hormones. The metabolism of the various amino acids is considered, including the urea cycle, one-carbon fragments, transamination reactions, and aromatic hydroxylations. Metabolism of nucleic acids and their building blocks are discussed, as well as the genetic basis of protein synthesis, the genetic code, and the mechanisms of control. *Prep. 90.822.*

Most undergraduate biology courses in the series designated 18.200–18.300 are available for graduate credit. Please consult the undergraduate or other appropriate bulletin for course details. In particular, the following courses are so considered:

18.206	**Evolution**	4 q.h.
18.207	**Vertebrate Zoology**	4 q.h.
18.208	**Comparative Vertebrate Anatomy**	5 q.h.
18.209	**Embryology**	5 q.h.
18.210	**Marine Invertebrate Zoology**	5 q.h.
18.211	**Parasitology**	4 q.h.
18.212	**Vertebrate Paleontology**	4 q.h.
18.216	**Herpetology**	4 q.h.
18.217	**Mammalogy**	5 q.h.
18.219	**The Microbial World**	4 q.h.
18.220	**General Microbiology**	5 q.h.
18.227	**Animal Histology**	4 q.h.
18.228	**Histological Technique**	3 q.h.
18.230	**Marine Botany**	4 q.h.
18.231	**Lower Plants**	4 q.h.
18.232	**Higher Plants**	4 q.h.
18.234	**Plant Anatomy**	4 q.h.
18.235	**Economic Botany**	4 q.h.
18.236	**Horticulture**	4 q.h.
18.238	**Local Flora**	4 q.h.
18.240	**Microbial Physiology**	4 q.h.
18.242	**Medical Microbiology**	4 q.h.
18.245	**Serology-Immunology**	3 q.h.
18.246	**Serology-Immunology Laboratory**	2 q.h.
18.248	**Marine and Freshwater Microbiology Laboratory**	2 q.h.
18.249	**Marine and Freshwater Microbiology**	2 q.h.
18.251	**Comparative Animal Physiology**	4 q.h.
18.252	**Vertebrate Physiology I**	3 q.h.
18.253	**Vertebrate Physiology II**	3 q.h.
18.260	**Advanced Cell Biology**	4 q.h.
18.265	**Introduction to Plant Physiology**	4 q.h.
93.180	**Physical Biochemistry**	4 q.h.
93.185	**Molecular Biology**	4 q.h.
93.190	**Advanced Biochemistry Laboratory**	4 q.h.

The following courses, offered by other departments within the University, are currently approved for graduate credit. The limitation on graduate credit for extradepartmental courses and transfer courses from other schools is *ten quarter hours* for these two categories combined. Credits above ten quarter hours may on special occasion be approved upon petition from the student (with supporting note from adviser) to the Graduate Director. A similar petition must be submitted if courses not on the list are desired for credit. Since not all such petitions are approved, it is strongly recommended that the petition be

submitted before you take the course. The Department will from time to time add or delete courses from this list. This will not affect students who have taken such courses previously.

12.161	**Physical Chemistry (lab)**	4 q.h.
12.166	**Physical Chemistry (no lab)**	3 q.h.
12.179	**Instrumental Analysis**	5 q.h.
12.180	**Ocean Chemistry**	4 q.h.
10.8H3	**Biostatistics**	2 q.h.
10.130	**Introduction to Computers and Computation (BASIC)**	4 q.h.
10.131	**Introduction to Computer Science (PASCAL)**	4 q.h.
10.215	**Information Structures**	4 q.h.
10.240	**Math Models for Natural Sciences**	4 q.h.
10.207	**Differential Equations**	4 q.h.
10.221	**Applied Analysis**	4 q.h.
11.871	**Radiation Physics (Theory)**	2 q.h.
11.872	**Radiobiology and Health Physics**	2 q.h.
11.246	**Electronics I**	4 q.h.
11.247	**Electronics II**	4 q.h.
19.193	**Neuroanatomy I**	4 q.h.
16.810	**Coastal Sedimentation**	4 q.h.
16.232	**Geomorphology**	4 q.h.
16.233	**Coastal Processes**	4 q.h.
73.814	**Concepts in Pharmacology I**	2 q.h.
73.816	**Concepts in Toxicology I**	2 q.h.
73.817	**Concepts in Toxicology II**	2 q.h.
72.866	**Phytochemistry**	2 q.h.
90.821	**Biochemistry I**	2 q.h.
90.822	**Biochemistry II**	2 q.h.
90.823	**Biochemistry III**	2 q.h.
93.110	**FORTRAN Programming**	4 q.h.
93.810	**Physical Biochemistry**	4 q.h.
93.190	**Advanced Biochemistry (lab)**	4 q.h.*
93.185	**Molecular Biology**	4 q.h.*
01.952	**Industrial Hygiene**	2 q.h.
01.957	**Air Pollution Science**	2 q.h.
87.833	**Immunobiology**	2 q.h.
87.857	**Cellular Pathology I**	2 q.h.
87.858	**Cellular Pathology II**	2 q.h.

*These courses will not count against the limit of ten external quarter hours.

chemistry

Professors

Philip W. LeQuesne, Ph.D., University of Auckland, Chairperson
Geoffrey Davies, Ph.D., Birmingham University
Bill C. Giessen, Dr. Sc. Nat., University of Gottingen
Arthur M. Halpern, Ph.D., Northeastern University
Barry L. Karger, Ph.D., Cornell University
John L. Neumeyer, Ph.D., University of Wisconsin
Robert F. Raffauf, Ph.D., University of Minnesota
William M. Reiff, Ph.D., Syracuse University
Robert A. Shepard, Ph.D., Yale University
Alfred Viola, Ph.D., University of Maryland
Karl Weiss, Ph.D., New York University

Associate Professors

David M. Howell, Ph.D., University of Michigan
Conrad M. Jankowski, Ph.D., State University of Iowa, C. Chem.
Elmer E. Jones, Ph.D., Washington University
John L. Roebber, Ph.D., University of California, Berkeley, Executive Officer
Paul Vouros, Ph.D., Massachusetts Institute of Technology
Robert N. Wiener, Ph.D., University of Pennsylvania

Assistant Professors

David A. Forsyth, Ph.D., University of California, Berkeley
Thomas R. Gilbert, Ph.D., Massachusetts Institute of Technology
Michael E. Kellman, Ph.D., University of Chicago
Kay D. Onan, Ph.D., Duke University
Mary J. Ondrechen, Ph.D., Northwestern University
David E. Seitz, Ph.D., Northwestern University

Admission

In addition to the admission requirements listed on page 19, an applicant must have completed a full year of undergraduate organic chemistry, physical chemistry, analytical chemistry, calculus, and physics. Admission policy favors those who have taken courses beyond the above minimum.

These admission requirements may be modified to accommodate applicants who have taken fewer courses than indicated above, but who have outstanding records and a strong interest in chemical or interdisciplinary studies. See also the description of interdisciplinary programs.

Program Planning

Prospective students and current students should discuss their programs with a departmental adviser. The departmental advisers may be reached by calling 437-2822 and would welcome discussion of curriculum matters and program planning.

DEGREE REQUIREMENTS

Part-Time Program Leading to M.S. Degree

This program consists of a total of forty quarter hours of credit in graduate course work, of which thirty-two credits must be taken in chemistry graduate courses numbered between 12.821 and 12.899. Eight additional credits may be taken in any graduate courses for which the student has the necessary prerequisites. The student's program must include the following core courses in the four areas of chemistry:

(a) Four credits of analytical chemistry. These may be chosen from 12.821 and 12.831, *or* 12.822 and 12.832, *or* 12.823 and 12.833.
(b) Four credits of inorganic chemistry. These will normally be the 12.841 and 12.842 sequence.
(c) Four credits of organic chemistry. These may be either the 12.861 and 12.862 sequence *or* the 12.864 and 12.865 sequence.
(d) Four credits of physical chemistry. These may be either the 12.881 and 12.882 sequence *or* the 12.885 and 12.886 sequence. Note that 12.881 and 12.885, by themselves, are not sufficient.

In cases of unusual preparation, more advanced courses may be substituted within the given subdiscipline.

Full-Time Program

Master's Degree

The normal full-time program consists of a total of forty quarter hours of graduate credit in courses, seminars, research, and a thesis based on this research. Each student is required to take at least twenty-four quarter hours of credit in graduate chemistry courses numbered between 12.821 and 12.899. Up to four quarter hours of graduate courses in physics or mathematics may be substituted. At least one two-quarter sequence of courses must be taken in three out of the four areas of chemistry. These sequences would normally be chosen from the following core courses:

(a) Analytical Chemistry—12.821 and 12.831, *or* 12.822 and 12.832, *or* 12.823 and 12.833.
(b) Inorganic Chemistry—12.841 and 12.842
(c) Organic Chemistry—12.861 and 12.862
(d) Physical Chemistry—12.881 and 12.882 *or* 12.885 and 12.886.

A minimum of six hours, but no more than fourteen quarter hours of credit may be assigned to 12.991 Research and Thesis for the Master of Science degree. Each student is required to attend 12.990 Seminar in each term. One credit is assigned to a student for each term in which the student conducts a seminar, up to the maximum of two credits.

DOCTOR OF PHILOSOPHY DEGREE

The doctoral program in chemistry may be pursued only in residence. The addi-

tional requirements beyond those of the master's degree are designed to provide the doctoral candidate an opportunity to demonstrate superior proficiency in original research, including technical reading ability in a foreign language and familiarity with current advances in one of the main divisions of chemistry.

Residence Requirement

The residence requirement is satisfied after one year of full-time graduate work or two years of half-time work. If a student holds a teaching assistantship which occupies one half of the student's time, the residence requirement is being discharged at half rate. Other arrangements require faculty approval. If a candidate has a research fellowship which supports the research for the doctoral dissertation, the residence requirement is discharged at full rate. Normally, the equivalent of two years of work after establishment of doctoral candidacy is necessary to complete research.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

Qualifying examinations are offered in the fields of analytical, inorganic, organic, and physical chemistry. There are eight examinations offered each year in each field. Students are required to pass four of these examinations in their declared field of study.

A student is eligible to take the qualifying examination if:

(a) the student has entered with a bachelor's degree and has achieved a 3.0 average in eight courses taken in the first year of residence. Two of the eight graduate courses may be in physics or mathematics, the remaining courses must be numbered between 12.821 and 12.899;

(b) the student has been admitted to the doctoral program with an awarded master's degree;

(c) the student is a part-time student who has petitioned the Department after having completed at least sixteen credits of graduate courses which include fulfillment of three of the four distributional requirements listed for the part-time program. A 3.0 average is required for all courses taken.

Students in category "a" must pass the qualifying examinations by July 1 of their second year of residence. Students in category "b" must pass the qualifying examinations by July 1 of their first year of residence. Students in category "c" will have the conditions set at the time their petition is approved.

Course Requirements

A candidate is normally required to complete some course work beyond the forty quarter-hour minimum. The number and nature of these courses are indi-

vidually determined for each candidate in consultation with the dissertation adviser.

Dissertation

In most cases, arrangements for a dissertation adviser will have been made before the completion of the qualifying examination. If not, such arrangements must be made as soon as possible after degree candidacy has been established. The dissertation adviser directs the research for the dissertation and serves as chairperson of the dissertation committee, which must approve the dissertation before the degree may be conferred.

Language Requirements

Candidates must demonstrate proficiency in a foreign language as specified by the departmental graduate committee in accordance with the general graduate school regulations. French, German, and Russian are the acceptable foreign languages. Normally, proficiency is demonstrated by taking examinations administered by the Chemistry Department.

Final Oral Examination

This examination will be held in accordance with the graduate school regulations.

AREAS OF ADVANCED STUDY AND RESEARCH

Analytical Chemistry

The general areas of active research in analytical chemistry include separation science; application of analytical methods to a wide range of problems in optical methodology; electronanalytical methods; and forensic, clinical, and oceanographic analysis.

Inorganic Chemistry

Research in inorganic chemistry is largely concentrated on the structure and properties of transition elements and their compounds. Current investigations range from solid-state studies to the thermodynamics and mechanism of reactions in solution. The application of inorganic chemistry in the field of forensic science is also under investigation.

Organic Chemistry

Research in the organic chemistry division encompasses the areas of organic synthesis, synthetic methodology, organic reaction mechanisms, carbocationic species, natural products, and phytochemistry.

Physical Chemistry

The physical chemistry division has active research programs in the areas of

photophysics, fluorescence spectroscopy, solution and gas phase photochemistry, molecular spectrscopy, physical solid-state chemistry including X-ray diffraction, small molecule X-ray crystallography, and theoretical studies of molecular systems.

Research Facilities and Equipment

The main facilities of the Department are located in Hurtig Hall. Substantial additional space and equipment are available in the Institute of Chemical Analysis, Applications, and Forensic Science in Mugar Hall, in the Forsyth Building, and at the University's Marine Science and Maritime Studies Center at Nahant. Major research equipment includes:

- electron spin, nuclear magnetic resonance, and mass spectrometers
- liquid and gas chromatographs and an atomic absorption spectrometer
- X-ray diffractometers, an electron microscope and thermal analyzers and calorimeters
- Gouy and Faraday magnetic balances and a vibrating sample magnetometer
- vacuum ultraviolet, photoionization, ultraviolet, visible, and infrared spectrometers
- flash photolysis, laser photolysis, and photochemical equipment
- Mossbauer spectrometer and low temperature facilities
- fluorescence emission and lifetimes and a stopped-flow apparatus
- electroanalytical, polarographic, and coulometric equipment

Interdisciplinary and Other Graduate Chemistry Programs

Some graduate students wish to pursue doctoral programs which involve substantial work in two or more departments. The Chemistry Department has served as the registration department for a number of students engaged in such areas. The details of establishing such a program tailored to a student's individual needs are explained on page 26 of this bulletin.

Interdisciplinary Ph.D. in Forensic Chemistry

This program is designed to help prepare students for research and leadership positions in forensic laboratories. It is offered in conjunction with the College of Criminal Justice and the Institute of Chemical Analysis, Applications, and Forensic Science. Details are given on page 62. Application material can be obtained by writing to:

Graduate Program in Forensic Chemistry
Institute of Chemical Analysis, Applications, and Forensic Science
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

Master of Science in Forensic Chemistry

This program is available on a full-time or part-time basis with courses being

offered primarily during the evening hours. Details are given on page 63. Application material can be obtained by writing to:

Graduate Program in Forensic Chemistry
College of Criminal Justice
144 Knowles-Volpe Hall
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

Master of Science in Clinical Chemistry

A part-time interdisciplinary program offered in cooperation with the College of Pharmacy and Allied Health Professions, the Master of Science in Clinical Chemistry program is designed to help prepare students for employment in clinical laboratories. Students must apply for this program through the College of Pharmacy and Allied Health Professions. Details are given on page 57.

DESCRIPTION OF COURSES

All courses carry two quarter hours of credit unless otherwise specified.

12.810 Modern Methods of Analysis (3 q.h.)
Training in a wide variety of modern methods of instrumental analysis with extensive "hands-on" experience offered by a laboratory section. Areas covered include data handling; spectroscopy (UV-visible and IR absorption, luminescence, X-ray, atomic absorption and mass spectrometry); separations (gas and modern liquid chromatography, TLC); pulse polarography; X-ray diffraction; microscopy (optical and scanning electron microscopy, including X-ray fluorescence microanalysis); computerized instrumentation. (Restricted to students in the Forensic Chemistry M.S. program, except by special arrangement.)

12.811, 12.812, 12.813 Special Topics in Chemistry; Chemistry and Society I, II, III
Special topics of current importance, including chemical aspects of the environment: pollution and its determination, pesticides, carcinogenics, resources; chemical aspects of energy conversion and storage: fossil fuels and fuel analysis; nuclear reactors; storage batteries; hydrogen production and storage; solar energy, photovoltaic cells and photochemistry; energy related materials. *Prep. Bachelor's degree in science or engineering.*

12.817 Modern Methods of Analysis (2 q.h.)
Similar to 12.810, but without laboratory *Prep. Consent of instructor.*

12.821 Analytical Separations
Theory and practice of analytical separation techniques. Emphasis is on fundamentals as they relate to practice. Topics for examination are based mainly on chromatographic processes including gas and high speed liquid chromatography. Other topics include zone refining, liquid-liquid extraction, and electrophoresis.

12.822 Electroanalytical Chemistry I
The theory, applications, and instrumentation for potentiometry, pH, ion selective electrodes, conductancy, and high-frequency measurements. The techniques of direct measurement, titration endpoint detection, and on-line measurements.

12.823 Optical Methods of Analysis I
Theory and practice of absorption spectrometric methods of analysis. Optics and basic instrumental considerations.

12.824, 12.825, 12.826 Special Topics in Analytical Chemistry I, II, III
Selected topics of current importance in analytical chemistry. *Prep. Consent of instructor.*

12.829 Computers in Chemistry (3 q.h.)
A laboratory-lecture course illustrating the use of small digital computers for real-time control of chemical instruments. Topics include digital-logic, real-time data structures, A/D and D/A conversion, noise and other aspects of real-time computer interfacing. Programming is done on a PDP-11 computer in MIRACL, a language designed for real-time processing. *Prep. Consent of instructor.*

12.831 Advanced Analytical Separations
Continuation of 12.821. *Prep. 12.821*

12.832 Electroanalytical Chemistry II
The theory, applications, and instrumentation for electrogravimetry, polarography, votammetry, chronopotentiometry, and coulometric titration. Techniques for direct measurement, titration endpoint detection, and on-line measurements. *Prep. 12.822.*

12.833 Optical Methods of Analysis II
Emission and fluorescence methods of analysis, including atomic techniques, X-ray fluorescence, and Raman spectrometry. *Prep. 12.823.*

12.841 Advanced Inorganic Chemistry I
Application of basic quantum chemistry to inorganic systems. Russell-Saunders and j-j coupling. Stereochemistry of nontransition-metal compounds; bonding and structure of electron-deficient systems.

12.842 Advanced Inorganic Chemistry II
Magnetic properties; electronic spectra and selection rules. Thermodynamic stabilty of coordination compounds. Experimental techniques of inorganic chemistry. *Prep. 12.841.*

12.843 Advanced Inorganic Chemistry III
Crystal symmetry. Introduction to theory of lokids; semi-conductors and metals; non-stoichiometric compounds; solid-state reactions. Application of molecular orbital theory. Determination of electron distribution in transition metal compounds. Mossbauer spectroscopy and advanced magneto-chemistry. *Prep. 12.842 and 12.885.*

12.846 Coordination Chemistry
Solution phase properties of coordination compounds. Experimental methods for the study of thermodynamics stability and kinetic lability. Kinetics and mechanism of solvent exchange and substitution reactions at transition metal centers. Classification of redox reaction mechanisms. Marcus theory. Phenomenological mechanisms. *Prep. 12.843.*

12.847, 12.848, 12.849, 12.850 Special Topics in Inorganic Chemistry I, II, III, IV
Advanced topics of importance in inorganic chemistry including advanced ligand field theory: crystal field theory of ions in weak and strong fields. Molecular orbital theory of transition metal complexes. Crystal structure determination in solids: crystallography, X-

ray, electron and neutron diffraction techniques applied to inorganic, bio-inorganic and other solids. Resonance spectroscopy in inorganic chemistry, including electron spin, nuclear magnetic, and nuclear quadrupole resonance; and Mossbauer spectroscopy. Solid-state chemistry: thermal, magnetic and transport properties; phase transformations and crystal defects; surface effects; material preparation techniques. *Prep. 12.842 and consent of instructor.*

12.861, 12.862 Advanced Organic Chemistry I, II
An intensive survey of organic reactions. Modern concepts of structure and mechanism are used to correlate factual material. *Prep. One year of organic chemistry.*

12.863 Physical Organic Chemistry
Topics in basic physical organic chemistry: molecular polarity, equilibrium and kinetics, reactivity and structure, solvent effects, acid-base catalysis, orbital symmetry, aromaticity. *Prep. 12.862 or consent of instructor.*

12.864, 12.865 Organic Stereochemistry and Reaction Mechanisms I, II
Interrelations of the stereochemistry of organic molecules with their physical and chemical behavior. Conformational analysis. The effects of spatial relationships on transition states, equilibria, and reaction rates as an introduction to the study of organic reaction mechanisms. *Prep. 12.863.*

12.866 Spectrometric Identification of Organic Compounds
Interpretation of the ultraviolet, infrared, and nuclear magnetic resonance spectra of organic compounds. *Prep. One year of Organic Chemistry.*

12.871, 12.872, 12.873 Special Topics in Organic Chemistry I, II, III
Selected topics of current importance in organic chemistry. *Prep. 12.862 and consent of instructor.*

12.876, 12.877 Organic Reaction Mechanisms and Organic Synthesis I, II
The fundamental factors influencing the courses of organic reactions. Substitution reactions. Pericyclic reactions. Synthetic methods as an introduction to organic synthesis. *Prep. 12.865 or concurrent registration therein.*

12.881 Chemical Thermodynamics I
First Law of Thermodynamics, thermochemistry, Second and Third Laws, free energies, reaction and phase equilibria. *Prep. Consent of instructor.*

12.882 Chemical Thermodynamics II
Partial molar properties, solutions, electrolytes. Statistical analogues of entropy and free energy, partition functions. *Prep. 12.881.*

12.883 Chemical Thermodynamics III
Statistical Thermodynamics applied to gases, liquids, and solids. Irreversible thermodynamics. *Prep. 12.882 and 12.886.*

12.885 Introductory Quantum Chemistry I
Introduction to quantum mechanics. Application to simple systems. Perturbation theory and applications. Harmonic oscillator, rigid rotor and applications to microwave and infrared spectroscopy. Simple atoms. *Prep. One year of Physical Chemistry.*

12.886 Introductory Quantum Chemistry II
The variational method. The chemical bond H_2^+. The LCAO method. Group theory and applications. Molecules. Woodward-Hoffman rules. *Prep. 12.885.*

12.887 Introductory Quantum Chemistry III
Application of group theory and simple approximate theories to conjugated molecules. The SCF method and its application to atoms and molecules. Applications to molecular spectroscopy. *Prep. 12.886.*

12.890, 12.891, 12.892 Special Topics in Physical Chemistry I, II III
Advanced topics of importance in physical chemistry including quantum chemistry: linear algebra and the formulation of quantum theory. Angular momentum. Group theory. Small molecules. Time-dependent theory and selected advanced topics. Statistical mechanics: quantum statistics; electrons in metals, photons, and phonons; superconductivity; fluctuations, noise, and irreversible thermodynamics; transport phenomena; phase transitions of high order. *Prep. Consent of instructor.*

12.893 Chemical Kinetics
Use of experimental data to deduce the rate law of a reaction. Mechanisms deduced from rate laws. Influence of experimental error on precision of rate constants and activation energies. Collision- and transition-state theories of reaction rates. *Prep. One year of physical chemistry.*

12.901 Polymer Chemistry I
Introduction to polymers. Major emphasis on synthesis. Step-reaction, chain-reaction, and ring-opening polymerizations. Copolymerization. Three-dimensional polymers and crosslinking. *Prep. One year of organic chemistry and one year of physical chemistry.*

12.902 Polymer Chemistry II
Physical chemistry of polymers in solution and bulk. Molecular characterization. Mechanical and physical properties in the glassy, rubbery, viscous, and semi-crystalline states. *Prep.12.901.*

12.903 Polymer Chemistry III
Industrial practice, polymer processing, fibers, elastomers, coatings, adhesives, and reinforced plastics. Relationship of polymer structure to usage. *Prep. 12.902.*

12.910 Special Projects in Chemistry
Laboratory studies on a topic not directly related to research pursued for a thesis. *Prep. Permission of the departmental faculty is required.*

12.990 Seminar (1 q.h.)
Oral reports by the participants on current investigations in chemistry. *Prep. Enrollment in full-time program.*

12.991 Research and Thesis for M.S. (maximum: 14 q.h.)
Original research and a written thesis thereon, under supervision of a faculty member.

12.995 Research and Dissertation for Ph.D.
Original research in depth, representing a significant contribution of new chemical knowl-

edge, and a written dissertation thereon, under the supervision of a faculty member. *Prep. Doctoral candidacy.*

90.821 Biochemistry I
Discussion of the structures and chemistries of carbohydrates, proteins, lipids, nucleic acids, and selected cofactors. *Prep. One year organic chemistry.*

90.822 Biochemistry II (2 q.h.)
Discussion of enzymes, enzyme kinetics, and mechanisms of enzyme reactions, of intermediary metabolism and of bioenergetics, biological oxidation-reduction reactions and the electron transport chain. A consideration is made of carbohydrate metabolism including the glycolytic pathway, the citric acid cycle and the pentose phosphate pathway. *Prep. 90.821. Offered summer and winter quarters.*

90.823 Biochemistry III
Continuation of intermediary metabolism from Biochemistry II, including lipid, protein, and nucleic acid metabolism, photosynthesis, and cell regulation. *Prep. Biochemistry II, 90.822.*

See the catalog of the Graduate School of Pharmacy and Allied Health Professions for other courses on chemical topics.

clinical chemistry

MASTER OF SCIENCE IN CLINICAL CHEMISTRY

Part-Time Program

Admission

In addition to the admissions requirements listed on page 19, the applicant must have completed a baccalaureate program in biology, chemistry, medical technology, or pharmacy. Undergraduate requirements in this program are a minimum of two quarters of organic chemistry and two quarters of analytical chemistry (each with a laboratory or its equivalent), two quarters of human physiology, and two quarters of physical chemistry. An individual who has deficiencies in any of these areas may take appropriate evening courses for undergraduate credit at Northeastern University concurrently with those graduate courses which do not require the deficient prerequisites. The appropriate evening courses offered at University College of Northeastern University are Analytical Chemistry 12.421-12.423 *or* 12.427; Organic Chemistry 12.431-12.433; Physical Chemistry 12.441-12.443; and Human Anatomy and Physiology 18.424-18.426. Equivalent courses from this University or other universities will be accepted.

This is an interdisciplinary program; applications should be directed to the Graduate School of Pharmacy and Allied Health Professions.

Program

The Master of Science in Clinical Chemistry program is interdisciplinary, offered in cooperation with Northeastern's College of Pharmacy and Allied Health Professions. Forty quarter hours of academic coursework are required. In addition, students must have at least one year of acceptable clinical laboratory experience prior to completion of academic degree requirements. Students in good standing in the program who lack the required experience may apply for the course 87.165, Clinical Chemistry Applied Study, which carries five quarter hours of undergraduate credit, two of which may be applied toward the master's degree. This course is offered through the College of Pharmacy and Allied Health Professions at one of the nearby affiliated hospitals, providing students the opportunity to earn three months' experience in a clinical setting. Students should consult the Medical Laboratory Science (MLS) Clinical Coordinator regarding prerequisite courses and the details for taking this course, which must be arranged at least six months in advance of enrollment in the course. Individuals who have completed this course may then be able to obtain subsequent employment in this field and thereby satisfy one year's experience requirement.

The program is available on a part-time basis with courses offered primarily during the evening hours. Courses are scheduled in the Fall, Winter, Spring, and Summer Quarters. The following core courses are required in the program:

		Total Credits
10.843	Biostatics	2
12.810	Modern Methods of Analysis	3
12.821	Analytical Separations	2
72.834	Clinical Chemistry I	2
72.835	Clinical Chemistry II	2
72.837	Seminar and Report in Clinical Chemistry I	2
72.845	Radioisotopes in Biological Systems	2
87.810	Functions of Human Systems	2
90.821	Biochemistry I	2
90.822	Biochemistry II	2
90.823	Biochemistry III	2
		—
		23

Twelve additional credits must be taken from the following elective core courses:

		Credits
12.822	Electroanalytical Chemistry	2
12.824	Special Topics in Analytical Chemistry I	2
12.825	Special Topics in Analytical Chemistry II	2
12.829	Computers in Chemistry	3
18.841	Human Genetics	2
72.838	Seminar and Report in Clinical Chemistry II	2
72.839	Seminar and Report in Clinical Chemistry III	2

72.861	Advanced Medicinal Chemistry I	2
72.862	Advanced Medicinal Chemistry II	2
72.863	Advanced Medicinal Chemistry III	2
72.864	Advanced Medicinal Chemistry IV	2
73.814	Concepts in Pharmacology I	2
73.815	Concepts in Pharmacology II	2
73.816	Concepts in Toxicology I	2
73.844	Drug Metabolism	2
87.811	Pathophysicology I	2
87.812	Pathophysicology II	2
87.821	Medical Laboratory Management I	2
87.822	Medical Laboratory Management II	2
87.832	Hematology I—Disorders of the Erythrocytes	2
87.833	Immunobiology	2
87.842	Hematology II—Disorders of the Leukocytes	2
87.857	Cellular Pathology I	2
87.858	Cellular Pathology II	2
87.861	Advanced Clinical Microbiology I	2
87.862	Advanced Clinical Microbiology II	2
87.890	MLS Seminar: Clinical Chemistry, Hematology, Immunology, Management, Microbiology	4
90.824	Applications of Mass Spectrometry	2

Selection of the remaining five quarter hours may be made from the above courses, as well as from the following and other appropriate courses in the Graduate School of Pharmacy and Allied Health Professions, or in the rest of the University, with the approval of the Director of the M.S. program in Clinical Chemistry.

		Credits
11.871	Radiation Physics	2
11.872	Radiobiology	2
12.841	Inorganic Chemistry I	2
12.842	Inorganic Chemistry II	2
12.846	Coordination Chemistry	2
12.861	Advanced Organic Chemistry I	2
12.862	Advanced Organic Chemistry II	2
12.863	Physical Organic Chemistry	2
12.866	Spectrometric Identification of Compounds	2
12.881	Thermodynamics I	2
12.885	Atomic and Molecular Structure I	2
18.893	Kinetics	2
18.245	Serology-Immunology	3
18.835	Genetics and Developmental Biology	2
18.840	Comparative Physiology of Regulatory Mechanisms	2
18.842	Vertebrate Endocrinology	3

18.843	Procedures in Endocrinology	3
18.860	Cell Biophysics and Biochemistry	5
18.909	Animal Virology	4
18.910	Microbial Genetics	3
19.920	Industrial Microbiology	3
18.940	Microbial Biochemistry	4
72.815	Nuclear Medicine I	2
72.816	Nuclear Medicine II	2
72.817	Nuclear Medicine III	2
72.818	Nuclear Medicine IV	2
72.844	Seminar and Research Report in Radiopharmaceutical Science	2
72.865	Special Topics in Medicinal Chemistry	2
72.866	Phytochemistry	2
72.867	Medicinal Chemistry Seminar	2
73.817	Concepts in Toxicology II	2
73.818	Special Topics in Pharmacology	2
73.820	Environmental Toxicology	2
73.846	Receptor Pharmacology	2
87.852	Hematology III—Coagulation	2
87.863	Advanced Clinical Microbiology III	2

DESCRIPTION OF COURSES

All courses carry two quarter hours of credit unless otherwise indicated.

Courses with the prefix number 12 are chemistry offerings. Their descriptions may be found in the preceding section of this bulletin along with interdisciplinary biochemistry courses (prefix number 90). The following courses are offered by the Graduate School of Pharmacy and Allied Health Professions.

72.834 Advanced Clinical Chemistry I
Significant articles from current issues of the journal *Clinical Chemistry* are discussed, covering a broad variety of recent topics in clinical chemistry and providing both an understanding of ongoing developments and an ability to read critically the current literature in this field. Methodology in clinical chemistry is presented, but interpretation is also included. *Prep. 90.823.*

72.835 Advanced Clinical Chemistry II
A continuation of Clinical Chemistry I. *Prep. 72.834.*

72.837, 72.838, 72.839 Seminar and Report in Clinical Chemistry I, II, III
Reports and discussions of current journal articles in clinical chemistry. *Prep. 72.835.*

72.845 Radioisotopes in Biological Systems
Methodology of radioactive nuclides and application of these isotopes to biology and medicine with special emphasis on their use in clinical analysis.

72.861 Advanced Medicinal Chemistry I (CNS Depressants)
Presentation and discussion of the chemistry, structure-activity relationships, and mecha-

nism of action of general anesthetics, hypnotics and sedatives, antiepileptics, analgetics, tranquilizers, and muscle relaxants. A consideration of the mechanics of drug design and methods of modification will be undertaken. *Prep. 73.814 or permission of instructor.*

72.862 Advanced Medicinal Chemistry II (Autonomic Drugs)
A discussion of drugs acting on the central nervous system, with special emphasis on the action mechanism of the chemical mediators of the peripheral nervous system. The role of the agents affecting this system—adrenergic and cholinergic and reversible and irreversible inhibitors of these systems—is discussed in relation to their chemical structure and biological activity. *Prep. 73.814 or permission of instructor.*

72.863 Advanced Medicinal Chemistry III (Anti-Infectives)
A study of various chemotherapeutic agents employed in the treatment of infectious diseases. Included are: the sulfonamides, antibiotics, antivirals; antitubercular, antifungal, and antimalarial agents. Special emphasis is on structure-activity relationships, mechanisms of action, and modern research in each area. *Prep. 73.814 or permission of instructor.*

72.864 Advanced Medicinal Chemistry IV (Cancer Chemotherapy)
Recent developments in new approaches to both carcinogenesis and to the treatment of cancer are emphasized, including alkylating agents, antimetabolites, hormones, miscellaneous compounds, and combinations of the above with radiation and immunology. Possible mechanisms of carcinogenesis and chemotherapeutic action explored. *Prep. 73.814 or permission of instructor.*

72.865 Special Topics in Medicinal Chemistry
A special area of medicinal chemistry, including either steroids, CNS compounds, pharmacodynamic agents or chemotherapeutics; their chemistry and structure. *Prep. 73.814 or permission of instructor.*

72.866 Phytochemistry
The important classes of chemical compounds produced by plants from the standpoint of their biogenetic origin, detection, isolation, and characterization. Application of these techniques to research in pharmacy, medicine, economics, botany, taxonomy. Introduction to the literature of plant chemistry. *Prep. Two quarters of Organic Chemistry and two quarters of Biology.*

73.816 Concepts in Toxicology I
An overview of toxicology describing the elements of method and approach that identify the science. Special emphasis is placed on the systemic site of action of toxicants. The intent of this part of the course is to provide answers to two questions: 1) What kinds of injury are produced in specific organs or systems by toxic agents? 2) What are the agents that produce these effects? *Prep. 73.814.*

73.817 Concepts in Toxicology II
Continuation of Concepts in Toxicology I. *Prep. 73.816.*

73.844 Drug Metabolism
Presentation of the current principles and methods for studying the metabolic transformation and physiological disposition of drugs and other chemicals of pharmacological and toxicological interest. The chemistry of Phase I and Phase II reactions from a mechanistic

and empirical viewpoint is covered. The role of structure, bonding, molecular configuration, substitution, and related physiochemical factors in the enzymatic reaction is assessed. The effects of enzyme induction and other factors such as species, sex, and age on the extent of metabolism are explored. *Prep. 72.814 or permission of instructor.*

87.810 Functions of the Human Systems
Histology and physiology of respiratory, urogenital, endocrine, nervous, and digestive systems. Lectures supplemented by current research articles and student reports. *Prep. Biology, Chemistry.*

87.811 Pathophysiology I
Disease processes as variants, inappropriate and appropriate, of normal physiological functions; a detailed examination of certain important and illustrative diseases rather than a survey or catalogue of diseases in general. *Prep. Mammalian physiology; knowledge of biochemistry is helpful.*

87.812 Pathophysiology II
A continuation of 87.811 Pathophysiology I. *Prep. 87.811.*

87.821 Medical Laboratory Management I
This course was developed to allow medical technologists the opportunity to prepare themselves for managerial reponsiblities. Participants are introduced to the basic skills and knowledge appropriate to the administration of a medical laboratory rather than specialized functional techniques. The basic objectives of the concentration are: to confront the student with appropriate learning experiences, to offer an opportunity to increase skills and knowledge in basic disciplines underlying administrative practice, and to help students to develop judgment and skills in problem analysis and decision making organizations. Major topics to be discussed include: supervison, operations, organizations, productivity, quality control, human behavior, communications, personnel management, and environment. *Prep. Medical laboratory experience or consent of instructor.*

87.822 Medical Laboratory Management II
A continuation of 87.821 Medical Laboratory Management I. Major topics to be discussed include: accounting, budgeting, purchasing, reimbursement, legalities, marketing, planning, and politics. *Prep. 87.821 or consent of instructor.*

87.833 Immunobiology
Lectures include topics of current interest in immunobiology, such as organ transplantation, immune tolerance, autoimmune diseases, and the immunology of cancer. *Prep. consent of instructor.*

Other biology, chemistry, and pharmacy courses may be taken with the approval of the Director of the M.S. program and the course instructor.

forensic chemistry

INTERDISCIPLINARY PH.D. PROGRAM IN FORENSIC CHEMISTRY

This program is offered in conjunction with the College of Criminal Justice and Northeastern University's Institute of Chemical Analysis, Applications, and

Forensic Science. This unique program is designed to provide the opportunity for preparation for research and leadership positions in forensic laboratories. The Chemistry Department is the registering department for two of the three specializations of this program, namely, forensic analytical chemistry and forensic materials science; a third specialization, forensic toxicology, is administered by the College of Pharmacy, again in connection with the College of Criminal Justice. Admission is made through the registering department.

For students entering with a B.S., completion of the M.S. course requirements in Forensic Chemistry (described below, page 63) with a 3.0 average is required to qualify for further Ph.D. study. For students with M.S. degrees in forensic science or the natural sciences, individual programs are planned according to the student's background. The course of study includes comprehensive examinations, thesis research to be carried out at the Institute of Chemical Analysis, Applications, and Forensic Science and an internship at a major forensic laboratory engaged in research. Application material can be obtained by writing to:

Graduate Program in Forensic Chemistry
Institute of Chemical Analysis, Applications, and Forensic Science
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

MASTER OF SCIENCE IN FORENSIC CHEMISTRY

Full-Time and Part-Time Program

Admission

In addition to the admissions requirements listed on page 19, the applicant must have completed a baccalaureate degree in the physical or life sciences. Undergraduate courses must include general chemistry, organic chemistry, analytical chemistry, physics, and calculus. An individual who has deficiencies in any of these areas may take the appropriate courses at Northeastern University concurrently with those graduate courses which do not require the deficient prerequisites. Although they are not prerequisites for the program, courses in general biology, botany, microbiology, and computer science are desirable. Application material can be obtained by writing to:

Northeastern University
Graduate Program in Forensic Chemistry
College of Criminal Justice
144 Knowles-Volpe Hall
360 Huntington Avenue
Boston, Massachusetts 02115

Program

The Master of Science in Forensic Chemistry is an interdisciplinary program involving cooperation among the College of Arts and Sciences, the College of

Criminal Justice, and the Institute of Chemical Analysis, Applications, and Forensic Science. Forty-two quarter hours of academic graduate coursework are required, including a Master's paper. In addition, a three-month internship consisting of full-time work in an approved, practicing forensic laboratory is required. The full-time program will thus generally encompass five quarters; this may be reduced to four quarters if the student can demonstrate to the satisfaction of the program committee the prior completion of three months or more of equivalent forensic laboratory experience. The program is available on a full-time or part-time basis; courses are offered primarily during the evening hours. Graduate courses are scheduled in the fall, winter, and spring quarters. The following are core courses required in the program.

Required Courses		**Credits**
12.810	Modern Methods of Analysis	3
73.814	Concepts in Pharmacology I	2
10.8H3	Biostatistics	2
92.841	Criminal Law	3
92.872	Criminal Evidence	3
92.904	The Criminal Justice Process	3
92.921	Arson, Explosives and Gunshot Residue	3
92.931	Crime Scene Investigation	3
93.950	Forensic Materials	2
93.951	Forensic Chemistry Techniques I	4
93.952	Forensic Chemistry Techniques II	4
93.953	Seminar	1
93.954	Master of Science Paper	4

Six additional credits must be taken from the following list of elective courses. Other graduate courses may serve as electives upon petition.

2.970	Material Science and Engineering	2
2.971	Material Science and Engineering	2
12.821	Analytical Separations	2
12.822	Electroanalytical Chemistry	2
12.823	Optical Methods of Analysis	2
12.824	Special Topics of Analytical Chemistry I	2
12.825	Special Topics of Analytical Chemistry II	2
12.826	Special Topics of Analytical Chemistry III	2
12.861	Advanced Organic Chemistry I	2
12.862	Advanced Organic Chemistry II	2
12.863	Physical Organic Chemistry	2
12.866	Spectrometric Identification of Organic Compounds	2
12.901	Polymer Chemistry I	2
12.902	Polymer Chemistry II	2
12.903	Polymer Chemistry III	2
18.245	Serology and Immunology	3
18.246	Serology and Immunology Lab	2

72.834	Advanced Clinical Chemistry I	2
72.835	Advanced Clinical Chemistry II	2
72.861	Advanced Medicinal Chemistry I	2
72.862	Advanced Medicinal Chemistry II	2
73.815	Concepts in Pharmacology II	2
73.816	Concepts in Toxicology I	2
73.817	Concepts in Toxicology II	2
73.844	Drug Metabolism	2
90.821	Biochemistry I	2
90.822	Biochemistry II	2
90.823	Biochemistry III	2
92.913	Criminal Justice Planning and Development	3
92.841	Criminal Law	3
93.956	Directed Study in Forensic Chemistry	2
93.957	Directed Study in Forensic Chemistry	3

Course descriptions may be found in preceding sections describing chemistry courses, or in the appropriate graduate catalogs.

economics

Professors
Morris A. Horowitz, Ph.D., Harvard University, Chairperson
Conrad P. Caligaris, Ph.D., Brown University
Harold M. Goldstein, Ph.D., Clark University
Daryl A. Hellman, Ph.D., Rutgers University
Irwin L. Herrnstadt, Ph.D., Massachusetts Institute of Technology
Sungwoo Kim, Ph.D., University of California, Berkeley
Gustav Schachter, Ph.D., New York University
Donald Shelby, Ph.D., University of California, Berkeley
Associate Professors
Ernest M. DeCicco, Ph.D., Boston University
Pawan K. Sawhney, Ph.D., Boston University
Andrew Sum, M.A., Massachusetts Institute of Technology
Assistant Professors
Neil Alper, Ph.D., University of Pittsburgh
Ranko Bon, Ph.D., Massachusetts Institute of Technology
Kamran Dadkhah, Ph.D., Indiana University
Barbara Fraumeni, Ph.D., Boston College
Jeanne K. Henn, Ph.D., Harvard University
Stephen A. Morrison, Ph.D., University of California, Berkeley
Edward Shea, Ph.D., Boston College
Gregory Wassall, Ph.D., Rutgers University

The Economics Department offers four terminal programs with different admission requirements and program form and content in an effort to serve students with varying backgrounds, interests and goals. These programs include a nondegree certificate program, an M.S. degree program in economic policy and planning, an M.A. degree program with specialization in one of four available fields, and a doctoral degree program.

CERTIFICATE PROGRAM

The Economics Department offers a nondegree program in the Economics of Manpower and Development Planning. Upon completion of the prescribed program, students will receive a certificate issued by the Graduate School of Arts and Sciences, Northeastern University. The program is designed for students who are interested in a specialized program of courses in manpower and development planning but who do not wish to meet the requirements of a degree program.

Admission

Admission to the program will be considered for graduates of recognized

universities or institutes of technology, although practical experience in manpower planning or development planning may be substituted for the admission requirements at the discretion of the faculty. All international students must submit a TOEFL test score or an equivalent certification of proficiency in English with the application and academic transcripts.

Program

This certificate program is designed to be completed in one year. Students admitted to the program may not transfer into the regular degree programs. Evidence of completion of a course and of the program shall be attendance, all required reading, and all written work. Successful completion of a course shall be noted by a pass designation.

Fall Quarter (All four courses required)

39.9F3	Introductory Microeconomic Theory
39.9F4	Introductory Macroeconomic Theory
39.9G1	Economics of the Labor Market and Labor Force
39.9P1	Economic Development

Winter Quarter (Select any two of three electives listed)

39.9F5	Introduction to Statistics (Required)
39.9G4	Economics of Manpower Planning I (Elective)
39.9P3	Regional Development (Elective)
39.9Q1	Development Finance (Elective)

Spring Quarter (Select any three of four courses listed)

39.9J1	Seminar in Human Resource Development
39.9R1	Seminar in Development Planning
39.9G5	Economics of Manpower Planning II
39.9P6	Comparative Economic Development

Variations in this basic program are possible only with prior approval of the departmental Graduate Director.

THE MASTER OF SCIENCE DEGREE IN ECONOMIC POLICY AND PLANNING

Forty-one quarter hours of academic work are required. The program consists of twenty-three quarter hours of required courses and eighteen quarter hours of electives. With the approval of the program adviser, a student may select a maximum of six quarter hours from graduate courses offered by other departments. This is a terminal degree program designed mainly for working economists, government agency officials, and middle echelon employees in the private sector.

Admission

Applicants must meet the general admission regulations of the Graduate School of Arts and Sciences.

Alternative Work-Study Program

The cooperative program has been central to Northeastern University's undergraduate education since its inception. Starting with the academic year 1982–83, graduate students enrolled in the Master of Science in Economic Policy and Planning may also enroll in an alternative work-study program. In this program, a student is on work assignment for three quarters and on campus for four quarters. A certain flexibility exists for students entering the program in the fall quarter. They may complete requirements in three quarters by taking four, rather than three courses each quarter. This flexibility does not, however, exist for students entering the program in the winter quarter because required core courses cannot be completed until the fourth quarter on campus.

Comprehensive Examination

After completion of courses, a comprehensive examination is required of all students to test their ability to apply concepts and tools in the broad field of economic policy and planning. The examination may be repeated only once.

Master's Thesis

A master's thesis for a maximum of six quarter hours of credit is optional, with the approval of the program adviser.

Course Requirements

A. Required Core Courses		Q.H. Credits
39.9F1	Seminar in Microeconomic Policy and Planning	4
39.9F2	Seminar in Macroeconomic Policy and Planning	4
39.9F3	Intermediate Microeconomic Theory	4
39.9F4	Intermediate Macroeconomic Theory	4
39.9F5	Introduction to Statistics	4
39.9F9	Workshop in Economic Policy and Planning	3

Students must receive a grade of B– or higher in all core courses. If a lower grade is received, a course meeting the core requirement must be taken or repeated.

B. Elective Courses

A total of eighteen hours of electives (twelve of which must be economics courses) may be selected by the student in accordance with interests and needs. Electives may be concentrated in any of the available areas or may be distributed among fields to obtain a broader exposure. All economics electives are valued at three quarter-hour credits. A maximum of six credits for courses taken at other institutions may be accepted if taken during the past seven years.

THE MASTER OF ARTS DEGREE

Forty quarter hours of academic work are required. This program comprises sixteen quarter hours of required core course work and twenty-four quarter hours of electives of which a minimum of twelve quarter hours must be selected from one of the economic fields listed below. The required core courses must be completed as soon as possible. With the prior approval of the graduate adviser, a student may select a maximum of six quarter hours from graduate courses offered by other departments, or two advanced undergraduate courses in economics carrying three quarter hours of graduate credit. The procedures for applying such credits towards the degree are described in the section on transfer credits on page 24.

Admission

In addition to the general admission requirements of the Graduate School of Arts and Sciences, applicants should have had a minimum of twelve semester hours of economics, or the equivalent, of which three semester hours, or the equivalent, should be statistics. Admission is only possible in the Fall and Winter Quarters. Application for admission to the Fall Quarter will be given consideration if received by July 31. Applications for admission to the Winter Quarter will be given consideration if received by October 31.

Applications for financial aid should be submitted no later than March 15. See page 29 for information on available financial aid.

Comprehensive Examination

A comprehensive examination, which will be held in accordance with the general graduate school regulations, must be taken by all students during the quarter in which the student completes the forty quarter hours of academic work. The examination may be repeated only once.

Master's Thesis

A master's thesis for six quarter hours of credit is optional with the approval of the graduate adviser. Approval will be granted only in those instances in which a student's previous graduate work indicates capacity for independent study.

Required Core Courses*

The following are required core courses:

39.9A1	Microeconomic Theory I **	4
39.9B1	Macroeconomic Theory I **	4
39.9E1	Statistical Inference***	4
39.9E7	Econometrics I	4

*Students must demonstrate competence in mathematics by taking a mathematics examination given by the department during registration week prior to the start of the fall quarter. Students must pass this exam or satisfactorily complete 39.9D0.

**Candidates deficient in intermediate theory may not be admitted into these core courses until they have completed 39.9A0 and/or 39.9B0.

***Students may meet the prerequisite of this course by passing a statistics examination given by the department during registration week prior to the start of the fall term or by satisfactory completion of 39.9E0.

Students may not receive more than one C grade in the core courses. If more than one C is earned, these courses must be repeated and a grade of at least a B– obtained.

Economic Fields

Available economic fields are listed below. Under each field are stated the required field courses and the elective field courses. Students must take at least twelve quarter hours in one field of concentration. In all fields, the first listed required course in the field ordinarily should be taken first by the student majoring in the field. For students not majoring in the field, courses in the field may be taken in any sequence.

Manpower Economics

Required field courses:

39.9G1	Economics of the Labor Market and Labor Force
39.9G4	Economics of Manpower Planning I
39.9J1	Seminar in Human Resource Development

Elective field courses:

39.9G5	Economics of Manpower Planning II
39.9G7	Human Resources and Labor Problems and Policies
39.9H1	Economics of Medical Care and Health Manpower
39.9H3	Economics of Education
39.9W1	Local Labor Markets
39.9W3	Human Resources Planning at State and Local Areas
39.9W5	Economics of Education and Training

Urban/Regional Economics

Required field courses:

39.9K1	Regional Economics
39.9L1	Urban Economic Systems
39.9L2	Urban Economic Development

Elective field courses:

39.9L5	Economics of Urban Transportation
39.9M1	Intergovernmental Fiscal Relations
39.9P3	Regional Development

Developmental Economics

Required field courses:

39.9P1	Economic Development
39.9P3	Regional Development
39.9R1	Seminar in Developmental Planning

Elective field courses:

39.9P6	Comparative Economic Development
39.9Q1	Developmental Finance
39.9G4	Economics of Manpower Planning I
39.9K1	Regional Economics

Economics of Money and Finance

Required field courses:

39.9S1	Monetary Theory
39.9S3	Monetary Policy
39.9V1	Seminar in Money and Finance

Elective field courses:

30.9T1	Public Policy and Finance
39.9T5	Capital Markets
39.9Q1	Developmental Finance
39.9M1	Intergovernmental Fiscal Relations

THE DOCTOR OF PHILOSOPHY DEGREE

The doctoral degree program in economics is offered in the fields of manpower, urban-regional, developmental, and monetary economics.

Admission

Applicants who will have a master's degree in economics or its equivalent at entry may be considered for direct admission to the doctoral program. Applicants who will not have a master's degree in economics or its eqivalent at entry may apply for admission to the doctoral program, but must satisfactorily complete an additional forty quarter hours of graduate work equivalent to a master's degree. Such students should submit the GRE scores if available.

Admission to the doctoral program is possible only in the fall quarter. Applications for the doctoral program must be submitted no later than March 15.

Residence Requirement

After acceptance to the doctoral program, the student may satisfy the residence requirement by one year of full-time graduate course work. Teaching assistants may satisfy the residence requirement by two consecutive years of half-time graduate course work. A student should expect to spend at least two academic years in full-time study, or its equivalent, completing the requirements for the doctoral degree.

Degree Candidacy

Degree candidacy is established in accordance with the general Graduate School regulations.

Course Requirements

A. At least thirty-two quarter hours of graduate work beyond the master's degree are required. These include:

Required Core Courses:

39.9A2 Microeconomic Theory II
39.9B2 Macroeconomic Theory II
39.9D1 Mathematics for Economists
39.9E8 Econometrics II

B. Concentration in one academic field. Course work in the field must include the doctoral seminar sequence 39.9C1 and 39.9C2. This seminar has a prerequisite of twelve quarter hours of graduate course work in the field.

Qualifying Exam

Each student must pass comprehensive qualifying examinations after the completion of the required core and field courses. These exams include: (1) a two-hour written exam in macroeconomic theory; (2) a two-hour written exam in microeconomic theory; (3) a two-hour written exam in quantitative methodology; (4) a three-hour written exam in one doctoral field; and (5) a two-hour general oral exam. Passing the qualifying exams signifies that the student has completed all course requirements and can then devote full-time work to the dissertation. An examination may be repeated only once.

Doctoral Dissertation

An original doctoral dissertation is required of all students in accordance with the general Graduate School regulations and the regulations established by the Department. After the successful completion of the qualifying examination, students are expected to work with dissertation advisers under whose guidance they write the doctoral dissertation. The dissertation advisor serves as chairperson of the dissertation committee which must approve the dissertation before the degree may be conferred.

Final Oral Examination

The final oral examination is established in accordance with the general Graduate School regulations.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

Courses indicating microeconomic theory as a prerequisite refer to 39.9F3 for M.S. degree students and 39.9A1 for M.A. degree students.

Courses indicating macroeconomic theory as a prerequisite refer to 39.9F4 for M.S. degree students and 39.9B1 for M.A. degree students.

39.9A0 Introduction to Intermediate Microeconomic Theory
Intensive coverage of basic micro theory. This course is designed for M.A. degree students who need to improve their background in micro theory and carries no academic credit toward the M.A. or Ph.D. programs.

39.9A1 Microeconomic Theory I (4 q.h.)
A non-math treatment of microeconomic theory at the beginning graduate level. An investigation of the conditions underlying consumer and producer equilibrium under different objective functions and various market structures. Derivation of product demand curves, supply curves, and factor demand curves for alternative market structures in product and factor markets are surveyed.

39.9A2 Microeconomic Theory II (4 q.h.)
An examination of contemporary microeconomic problems and theory with specific emphasis on welfare economics, general equilibrium, distribution, the theory of the firm, and the ability of modern value theory to reach meaningful and feasible policy conclusions. *Prep. 39.9A1 and consent of instructor.*

39.9A5 Case Studies in Applied Microeconomics
Topics in applied microeconomics. Case studies in organizational decision making for such problems as short-run and long-run forecasting of demand, price policy, financing of investments, location of plants, and response to government regulations and taxation. *Prep. 39.9A1 or 39.9F3.*

39.9A9 Economics and the Law (1 q.h.)
Topics in the application of microeconomic priciples to the law, such as property rights, torts, contract law, and the regulation of business. *Limited to Law, Policy, and Society students.*

39.9B0 Introduction to Intermediate Macroeconomic Theory
Intensive coverage of basic macro theory. This course is designed for M.A. degree students who need to improve their backgroud in macro theory and carries no academic credit toward the M.A. or Ph.D. programs.

39.9B1 Macroeconomic Theory I (4 q.h.)
Income and employment theory; classical, Keynesian, and post-Keynesian aggregate demand and supply systems.

39.9B2 Macroeconomic Theory II (4 q.h.)
Theory and problems of macro-dynamics, growth, inflation, cycles, and stabilization policy. *Prep. 39.9B1 and consent of instructor.*

39.9C1 Doctoral Research Seminar I (4 q.h.)
Prep. 12 q.h. of field work and consent of instructor.

39.9C2 Doctoral Research Seminar II (4 q.h.)
Prep. 39.9C1.

39.9D0 Introduction to Mathematics for Economists (0 q.h.)
This course helps acquaint students with matrix algebra and elementary calculus necessary for quantitative economics: simultaneous linear systems; polynomial, logarithmic, and exponential functions; and elementary differential and integral calculus. *This course offers no credit toward a degree in economics.*

39.9D1 Mathematics for Economics (4 q.h.)
Application of matrix algebra and simple multivariate calculus to economic analysis. Static organization and dynamic analysis; difference and differential equations. Examples from economic theory. *Prep. 39.9D0 or mathematics examination.*

39.9E0 Introduction to Statistics (0 q.h.)
An introduction to statistical methods and techniques used in economic analysis. Descriptive statistics, time-series and index number problems, sampling problems, introduction to probability theory, and hypothesis testing. This course is designed for M.A. degree students who need to improve their background in basic statistics and carries no academic credit toward the M.A. or Ph.D. programs.

39.9E1 Statistical Inference (4 q.h.)
A study of statistical methods and techniques. Probability theory and models, testing economic hypotheses, analysis of variance, ordinary least-squares regression, t-statistics and f-statistics. Correlation analysis. *Prep. 39.9E0 or equivalent.*

39.9E5 Economic Programming
Economic programming with emphasis on linear programming, simulation and queuing theory with applications to the computer. *Prep. 39.9D1.*

39.9E6 Accounting for Economists
An overview of private and public sector accounting systems and techniques to assist students in developing the ability to use these techniques in obtaining data and analyzing problems. Topics covered include national income accounts, balance-of-payment accounts, the private firm's balance sheet, income statement and flow-of-funds statement. Other issues, such as real vs. nominal magnitudes and depreciation techniques, are also covered.

39.9E7 Introduction to Econometrics (4 q.h.)
Estimation of demand, supply, cost, and production functions; applications of multivariate analysis of economic data; identification; determination of trend, oscillation, and periodic movements; autocorrelation and correlogram analysis, trends in multiple regression.

39.9E8 Econometrics II (4 q.h.)
Asymptotic and small sample properties of various estimators; rank-order conditions for identification; specification error and error in variables; remedies for autocorrelation and multicollinearity; dummy variables; distributed lags; forecasting and simulation; non-linear estimation; alternative estimation technique (two-stage least squares, three-stage least squares, maximum likelihood estimators, etc.) *Prep. 39.9E7.*

39.9F1 Seminar in Microeconomic Policy and Planning (4 q.h.)
Cost efficiency and effectiveness, assessment of externalities, shadow prices, benefit-cost analysis, project implementation and evaluation, budget analysis, evaluation of pub-

lic programs, role of private and public sectors, relationship of projects and macro planning, use of analysis by policymakers. *Prep. 39.9F3, 39.9F4, 39.9F5 co-requisite.*

39.9F2 Seminar in Macroeconomic Policy and Planning (4 q.h.)
Role of public sector in the economy. Socio-economic objectives and public policies. National economic planning and synthesis of models for growth and development. Tools and techniques for economic planning. Construction and utilization of input-output tables. Planning and Policy implementation and evaluation. *Prep. 39.9F3, 39.9F4, 39.9F5 co-requisite.*

39.9F3 Introduction to Intermediate Microeconomic Theory
The price mechanism, competitive and noncompetitive markets, accounting of the firm, production analysis, consumption analysis, labor markets (wage theory), income distribution, welfare economics. *(4 cr. for MSEPP)*

39.9F4 Introduction to Intermediate Macroeconomic Theory
National income definitions and measurements, Keynesian models, multipliers, growth models, investment, consumption and monetary theories. *(4 cr. for MSEPP)*

39.9F5 Introduction to Statistics
An introduction to statistical methods and techniques used in economic analysis. Descriptive statistics, time-series and index number problems, sampling problems, introduction to probability theory, and hypothesis testing. *(4 cr. for MSEPP)*

39.9F7 Introduction to Mathematics for Economists
Seeks to acquaint the student with the algebra and elementary calculus necessary for quantitative economics: simultaneous linear systems; polynomial, logarithmic, and exponential functions; and elementary differential and integral calculus. *(3 cr. for MSEPP)*

39.9F9 Workshop in Economic Planning and Policy
Empirical work involving micro and macro planning techniques, applying the latter to individual case studies of a specific plan, program, or organization. Students are expected to prepare and present a research paper on a chosen case study, demonstrating the ability to use planning techniques. *Prep. 39.9F1 and 39.9F2.*

39.9G1 Economics of the Labor Market and Labor Force
Labor force measurement and determinants, women's changing role in the labor market; micro-analysis of labor supply and demand, varieties of labor markets and their functioning; minimum wages; wage structures and differentials, labor allocation and migration; union impact on wage levels and structures; macro-wage-employment determination, macro-wage-price problems, income policies. Applications to developing and developed economies.

39.9G4 Economics of Manpower Planning I
The role of manpower planning and its integration with general development planning. Analysis and evaluation of different techniques of manpower planning. Technological versus economic methods. Practice of manpower forecasting and data problems. Skill training versus educational strategies. Models of educational planning and their applications to different countries. *Prep. Microeconomic Theory.*

39.9G5 Economics of Manpower Planning II
Applications of manpower planning methods and techniques to problems of national economic development. Cost-benefit and cost-effectiveness of educational and manpower programs. Special problems of health manpower, scientists, engineers, and technicians. Evaluation of methods and prediction used in national manpower plans. *Prep. 39.9G4.*

39.9G7 Human Resources and Labor Problems and Policies
Unemployment and underemployment, technological change and changing skill requirements; income distribution and poverty; human capital theories and human resource development; employment and training policies to raise personal earnings, income maintenance programs. Topics discussed in relation to developing and developed economies.

39.9H1 Economics of Medical Care and Health Manpower
The organization of medical care, the problems associated with various alternative delivery systems. The utilization and availability of physicians and other paramedical personnel, the growth and pressures exerted by third-party payers; and consideration of federal, state, and municipal participation in the delivery of quality medical care under various alternatives for national health insurance.

39.9H3 Economics of Education
An examination of the contribution of education to the process of economic growth and the way education is produced and distributed. Special topics include inequalities in returns to eduction; the role of intelligence and class background in educational success; and socializing role of education in production.

39.9J1 Seminar in Human Resource Development
Selected topics on the development and use of human resources. *Prep. Consent of instructor.*

39.9K1 Regional Economics
Delineating regions. Theories of location for firms, industries, and people. Regional income accounting systems and models of intra- and interregional income determinants and impact analysis. *Prep. Microeconomic Theory.*

39.9K4 Externalities
Theoretical foundations for urban and regional economics. Survey of economic theory related to externalities and welfare economics. *Prep. 39.9A1 and consent of instructor.*

39.9K5 Economics of Crime
A discussion of the resource allocation problem as it relates to criminal behavior and effective law enforcement. Evaluation of costs and benefits of alternative law enforcement policies. Criminal activity, including organized crime, is analyzed in an economic context.

39.9L1 Urban Economic Systems
The econony of cities. Analysis of intrametropolitan spatial relationships including residential location, land, and housing markets. *Prep. Microeconomic Theory.*

39.9L2 Urban Economic Development
Continuation of Urban Economic Systems. Problems in urban economics including segregation, housing, transportation, urban renewal, and related policy issues. *Prep. 39.9L1.*

39.9L5 Economics of Urban Transportation
Urban agglomeration, economic activities, residential concentration, and transportation network; urban and suburban densities in relation to the central place; capital budgeting; pricing; costs incidence and externalities of various modes; cost-benefit analysis; effects of transportation patterns on urban socioeconomic life; modal split and forecasting economic requirements for integrated urban transport needs.

39.9L7 Economics of Intercity Transportation
Investigates the rationale for intercity freight and passenger movements within the framework of interregional commodity flows. The choice of mode once traffic volume has been determined. Study also covers the economic and environmental impacts of the choice of mode.

39.9M1 Intergovernmental Fiscal Relations
A study of the development of the federal system, interstate and interarea fiscal comparisons, grants-in-aid, tax credits, revenue sharing, state and local taxes, nontax revenues, borrowing and budgeting at the state and local level, and a discussion of the process and prospects of state and municipal equalization of tax burden and effort. *Prep. Microeconomic Theory.*

39.9N1 Seminar in Urban/Regional Economics
Selected topics in urban/regional economics. *Prep. Consent of instructor.*

39.9P1 Economic Development
A study of the prospects of economic growth in less developed areas. Measurement and theories of economic development. Role of human and natural resources, education, technology, and capital formation in national, regional, and sectoral development. Changes in institutions.

39.9P3 Regional Development
Methodology and application of techniques for planning in multiregional systems. Empirical examples.

39.9P6 Comparative Economic Development
Case studies of less developed countries at differing stages of economic development.

39.9Q1 Development Finance and Trade
Sources of investment finance in developing countries; role of taxation and tax structure reform; development of financial institutions and capital markets; private and official finance from abroad and debt-service problems; problems of monetary management and export instability.

39.9R1 Seminar in Development Planning
Political and economic plans. Survey of neoclassical growth models. Input-output techniques in open and closed models. Elements of linear programming; optimal decision techniques. Processes of implementation of planning; interaction of public and private sectors. Guide to empirical applications. *Prereq. 39.9F4 or 39.9B1 and 39.9P1 or consent of instructor.*

39.9S1 Monetary Theory
A study of the relationships between money and economic activity with emphasis upon various quantity theory models and theories of the demand for money and velocity. *Prep. Macroeconomic Theory.*

39.9S3 Monetary Policy
A study of the interrelationships between aggregate economic activity, financial markets, and central banking instruments, objectives, and policy.

39.9T1 Public Policy and Finance
Techniques of fiscal policy, fiscal policy norms, public sector debt; tax policy; federal tax reform; the conflict between social implications of price stabilization and full employment; public expenditure policy and the interrelationship between monetary and fiscal controls. *Prep. Macroeconomic Theory.*

39.9T5 Capital Markets
Primary sources of savings and demand for financial assets; role of financial intermediaries; banking system and government lending agencies. Demand for funds and real investment—mortgage, corporate, and government securities markets; interdependence of rate structures. Flow-of-funds data in relation to national income accounts.

39.9V1 Seminar in Money, Credit, and Banking
Selected topics in the economics of money, credit and banking. *Prep. Consent of instructor.*

39.9W1 Local Labor Markets: Research Methods and Problems
Analytical framework and empirical measures for determining the nature and operation of state and local labor markets. Varieties of local labor markets; use of data from public agencies to examine such markets; composition of local labor force, sources of local labor supply, industrial and occupational mix, local wage and salary structures, local income distribution.

39.9W3 Human Resources Planning at State and Local Areas
Applied workshop in methods and techniques for planning human resource programs at state and local levels. Economic tools for state employment services, prime sponsors, and other service deliverers for designing, implementing, monitoring, and evaluating employment and training programs. Use of statistical packages in human resources planning.

39.9W5 Economics of Education and Training Programs
Economic analysis of the relative effectiveness of different education and training programs at the state and local level. Implications of human capital theory; methods for coordinating alternative programs and determining their effectiveness. Rates of return, cost-effectiveness, cost-benefit. Applications to policy and program planning.

39.9Z1 Master's Thesis Seminar (maximum 6 q.h.)
Thesis supervision by members of the Department; approval of graduate adviser required.

39.9Z2 Readings in Economics (up to 3 q.h.)
Supervised reading in selected topics in economics. *Prep. Consent of instructor and approval of graduate adviser.*

39.9Z5 Doctoral Dissertation Seminar (no credit)
Prep. Approval of graduate adviser required.

english

Professor Emeritus
Samuel F. Morse, Ph.D., Boston University
Professors
Kinley E. Roby, Ph.D., Pennsylvania State University, Chairman
Samuel J. Bernstein, Ph.D., Brandeis University
Robert J. Blanch, Ph.D., State University of New York, Buffalo
Earl Harbert, Ph.D., University of Wisconsin
Victor E. Howes, Ph.D., Yale University
M. X. Lesser, Ph.D., Columbia University
James Nagel, Ph.D., Pennsylvania State University
Jane A. Nelson, Ph.D., University of Michigan
Herbert L. Sussman, Ph.D., Harvard University
Arthur J. Weitzman, Ph.D., New York University
Paul C. Wermuth, Ph.D., Pennsylvania State University
Associate Professors
Francis C. Blessington, Ph.D., Brown University
Timothy R. Donovan, Ph.D., University of Wisconsin
Irene R. Fairley, Ph.D., Harvard University
Daniel Golden, Ph.D., Indiana University
Gary Goshgarian, Ph.D., University of Wisconsin
Gerald R. Griffin, Ph.D., University of Massachusetts
Guy Rotella, Ph.D., Boston College
Lloyd A. Skiffington, Ph.D., University of Massachusetts
Joseph E. Westlund, Ph.D., University of California, Berkeley
Assistant Professors
Richard Bullock, Ph.D., University of Virginia
Helen Loeb, Ph.D., University of Wisconsin
Ruth MacDonald, Ph.D., Rutgers University
Stuart S. Peterfreund, Ph.D., University of Washington

THE MASTER'S DEGREE

The Department of English offers a program leading to the M.A. degree. The courses emphasize training in research and criticism in the fields of English and American literature, or a concentration in linguistics and writing, and provide students the opportunity to acquire the comprehensive background necessary for a career as a scholar, teacher, or writer.

Admission

Applicants are judged favorably if they do superior work in their undergraduate preparation and do significantly better than average in the verbal and advanced sections of the Graduate Record Examination, the scores of which are

required before an application will be considered. An applicant is expected to have had at least twenty-four semester credits in English courses on a four-point scale. Recommendations should be submitted by English professors familiar with the student's work. An applicant who is deficient in any one of these areas may be admitted as a provisional student.

The category of special student is provided for those nondegree students who wish to take a summer course or those already enrolled in a graduate program in another institution who wish to transfer credit. An applicant already holding a graduate degree in English may also enroll as a special student. Application procedures are outlined on page 19.

Program

A total of fourteen courses or forty-two quarter hours is required, of which three quarter hours must be taken from each of the following groups:

I. Bibliography
II. Medieval literature, or theories of criticism, or linguistics
III. Sixteenth- and seventeenth-century English literature or seventeenth- and eighteenth-century American literature
IV. Eighteenth- and nineteenth-century English literature or nineteenth-century American literature
V. Twentieth-century English literature or twentieth-century American literature

Each student must also satisfy the requirements by taking at least one course in English literature before 1800 and at least one in American literature.

A total of fifteen quarter hours of seminar courses is required.

A student must elect at least one area in American and one in British literature on the comprehensive examination.

Concentrations in British and American literature, or a concentration in linguistics and writing, are also offered.

Concentration in British Literature

A total of fourteen courses or forty-two quarter hours is required, of which eight courses/twenty-four quarter hours must be distributed as follows:

I. Bibliography (one course/three quarter hours)
II. Medieval literature, or theories of criticism, or linguistics (one course/three quarter hours)
III. Sixteenth- and seventeenth-century English literature (two courses/six quarter hours)
IV. Eighteenth- and nineteenth-century English literature (three courses/nine quarter hours)
V. Twentieth-century British literature (one course/three quarter hours)

Two courses/six quarter hours are required in American literature.

A total of fifteen quarter hours of seminars is required.

The student must elect three areas in British literature on the comprehensive examination, one of which must be the individual work.

Concentration in American Literature

A total of fourteen courses or forty-two quarter hours is required, of which seven courses/twenty-one quarter hours must be taken from the following groups with at least one course from each group.

I. Bibliography (one course/three quarter hours)
II. Medieval literature, or theories of criticism, or linguistics (one course/three quarter hours)
III. American literature to 1800 (one course/three quarter hours)
IV. Nineteenth-century American literature (one course/three quarter hours)
V. Twentieth-century American literature (one course/three quarter hours)

An additional two courses/six quarter hours must be taken in English literature. One of them must be in literature before 1800.

A total of fifteen quarter hours of seminars is required.

The student must elect three areas in American literature on the comprehensive examination, one of which must be the individual work.

Concentration in Linguistics and Writing

A total of fourteen courses or forty-two quarter hours is required, of which seven courses/twenty-one quarter hours must be in linguistics and writing. One course must be taken in each of the following groups:

I. 8C3 English Grammar

II. 8C5 History of the Language
8C7 Language and Its Structure
9C7 Linguistics and Literary Study
9C8 Linguistics and the Art of Writing

III. 9B3 English Prose Styles
8R4 Theory and Teaching of Writing
9S6 Problems in Writing
9R3 Writing for the Professions

In addition, the student must take:

A. 30.8A1 Bibliography
B. One course in American literature
C. One course in British literature

A total of fifteen quarter hours of seminars is required.

Transfer Credit

A student may transfer from another institution no more than twelve quarter hours (nine semester hours) of graduate credit in English. Within this limit, gra-

duate courses in other fields may also be transferred if their relevance to the student's specialized interest can be demonstrated. Please refer to the section on transfer credit on page 24 for full details.

Thesis

A thesis is optional. A student wishing to write a master's paper must secure the approval of a graduate faculty member and write the thesis under the supervision of an adviser. Six credits in lieu of course work are allowed. The student must enroll in 30.9Z1, Thesis, to obtain credit. Papers must conform to the guidelines laid down in the *MLA Style Sheet*.

Directed Study

A student may apply for a maximum of six hours of directed study, not including a thesis.

Students should obtain the consent of their academic adviser and then that of the instructor who will direct the study. A course proposal should be developed, outlining the works to be covered, the general requirements to be met, and the credits for which the study is offered. Such a proposal should be submitted for approval to the Graduate Committee Chairperson in the English Department. The proposal becomes part of the student's file.

Directed study is not advised when a course in the same concentration is to be offered during the academic year, unless that course serves as the basis for more detailed study in the same area. Where possible, directed study should be organized around a specific problem or figure and should not, as a rule, substitute for regular course offerings.

Comprehensive Examination

A four-hour comprehensive examination, given during the fall and spring quarters, is required. Copies of previous examinations are available in the main departmental office. A student must accrue thirty quarter hours of credit with an average of 3.0 or higher before being eligible to take the examination. The examination may be taken only twice. Students may choose an oral examination in lieu of the written comprehensive. Students who wish to pursue this option must arrange to do so through the Graduate Committee Chairperson.

Language Requirement

A degree candidate must pass a reading examination in French, German, or Latin, to be offered during the fall and spring quarters. Students may petition for exemption.

Grades

To qualify for the comprehensive and for the degree, a student must achieve a minimum Q.P.A. of 3.0. Students who receive more than two C's in their first

two quarters of residence may be dropped from the program. An incomplete grade is granted only in extraordinary circumstances and not given automatically; the student *must arrange* with the instructor a timetable within which the unfinished work may be completed. Professors retain the right to award an F grade should the student fail to finish work in the stipulated time. I grades automatically become permanent after a year's passage. See page 22 for a more complete breakdown of grades awarded.

Residence and Time Limitation

A student who does not register for a course in a calendar year must reapply for admittance to the program. Course credits are valid for a maximum of seven years unless an extension is allowed by the Director of the Graduate School of Arts and Sciences.

Awards

A limited number of Teaching Assistantships (TAs) are awarded on a competitive basis. All applicants and students are potential candidates. If you think you have special qualifications, not apparent in your application, you are invited to submit evidence to the Graduate Committee Chairperson. Normally a Teaching Assistant takes two courses each quarter, but may take more with permission. Teaching Assistants are expected to maintain a superior average in course work and make satisfactory progress toward the degree.
Northeastern University Tuition Assistantships are tuition waiver awards. For further details regarding assistantships see page 31.

Extension Courses

No more than twenty-one credits in Northeastern courses given at the Burlington campus will be credited toward the degree.

CERTIFICATE OF ADVANCED GRADUATE STUDY

The Department of English offers a program of advanced work in humanistic literary study leading to a Certificte of Advanced Graduate Study. It is designed for those people who already hold the master's degree. Neither an intermediate step toward a research-oriented Ph.D. nor instruction in pedagogy, the program is designed as "state-of-the-art" training in literary studies. The program is directed toward practitioners in the field as well as those for whom continuing literary study is an end in itself. The program is designed for both full-time and part-time study. Limited financial aid is available.

Admission

Applicants must have a master's degree and are expected to submit transcripts of undergraduate and graduate work, but not letters of recommendation.

Program

Each student will follow an individualized coherent course of study built around his or her own needs and designed in close association with a faculty adviser. The student will develop the outline of this program by the end of the first quarter of work at Northeastern and follow the program, under the supervision of the adviser, throughout his or her work at Northeastern. Forty-two quarter hours of work are needed to complete the program. With permission of the adviser, the student may take up to three graduate courses in any other department.

Examination

The student must pass an individual comprehensive examination based upon his or her own program of study. The examination includes the evaluation of a lecture/classroom presentation.

TECHNICAL WRITING TRAINING PROGRAM

The Department of English, in cooperation with the Gradute School of Arts and Sciences, offers a training program in computer science and technical writing for those holding at least a bachelor's degree in English, education, or other liberal arts discipline. The program is directed toward experienced writers who have had at least one programming course. Enrollment is limited to twenty students.

This full-time special program leads to a certificate of completion. Although no degree is awarded, the English courses carry full graduate credit.

Admission

Candidates must submit undergraduate and graduate transcripts, Graduate Record Examination scores, three letters of recommendation from professors familiar with their work, and professional or academic writing samples. Candidates are also required to submit scores which should be above average on the SRA Computer Programmer Aptitude Battery.

Program

This certificate program is designed to be completed in one academic year. Three intensive courses in computer science and three intensive courses in technical writing are required; they will be determined in advance by the program directors. Transfer credits are not allowed.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified. All seminars are noted by a 900 level designation.

GROUP I

(three quarter hours required)

30.8A1 Bibliography and Literary Historiography
Materials and techniques of research in English and American literature; bibliography, form, and content of papers and theses; problems of literary history.

GROUP II

(three quarter hours required)

30.8B1 Theories of Criticism
An introduction to the study of modern and contemporary literary theory and criticism: "New Critical," Marxist, psychoanalytic, structuralist, post-structuralist, phenomenological, and others.

30.8C3 English Grammar
Methods and analytic procedures (but not the formalism) of modern linguistics are used to justify and support categories, distinctions, and structure used to describe sentences. These categories, distinctions, and structures will come mainly from the framework of traditional grammar. However, the inconsistencies and arbitrariness common in traditional grammar will be replaced by modern analyses, informally presented.

30.8C4 Semantics
The relation between language and behavior; the concept of change, variety, and uniqueness; symbols; levels of abstraction, habits of evaluation of linguistic phenomena; representation of meaning in language.

30.8C6 History of the English Language
Topics include the development of the sound system from Old English to the present; changes in the inflectional system and corresponding developments in sentence structure; processes of word formation and shifts in meaning. Poetry, prose, and nonfictional readings supplement the text.

30.935 Topics in Linguistics
Subject to be announced.

30.8C7 Language and Its Structure
Introduction to the study of language, the principles and methods of linguistic description; the development of the science of language, of descriptive and generative linguistics. Emphasis on goals of modern linguistic theory.

30.8D6 Chaucer's *Troilus and Criseyde*
A detailed examination of the poem.

30.8D7 Chaucer's *Canterbury Tales*
Selected *Canterbury Tales*.

30.9C2 Descriptive Linguistics
Intonation (stress, pitch, juncture); phonemics; morphemes and morphology; syntactic devices; the process of communication; variation in speech.

30.9C5 Transformational and Generative Grammar of English
Deep and surface structures and transformations necessary to generate the latter; graphic representations of structure; deep-structure nature of adjectives, pronouns, prepositions, auxiliaries, possessives, comparison with traditional grammar.

30.9C7 Linguistics and Literary Study
Language viewed in its special function as literary medium. Linguistic approach to style, metaphor, form, and meaning. Representative works of major writers, poetry and prose, studied for characteristic formal properties. Discussion of contribution of linguistic analysis to literary criticism and to a theory of literature.

30.9C8 Linguistics and the Art of Writing
Aspects of linguistics related to written forms of communication. Both fictional and nonfictional prose are represented. Topics in discourse analysis, textual cohesion, point of view and its effect on syntactic options, syntactic symbolism where syntax replicates meaning. Such problems as language and deception, speech and judgment, rhetoric and persuasion are also considered.

30.9D5 Middle English Lyrics and Drama
A study of the epic and romance, concentrating on the transformation of the epic to the courtly hero: works to include in translation *Beowulf*, *Chretian de Troyes*, the *Niebelungenlied*, and *Le Morte D'Arthur*.

30.9D8 Studies in Fourteenth-Century Literature
Major works in non-Chaucerian Middle English including *Sir Gawain and The Green Knight*.

GROUP III

(three quarter hours required)

30.8E1 Tudor Poetry
Wyatt and Surrey, Sidney, Marlowe, Spenser, Shakespeare: the poems of courtly love and the reaction against it.

30.8E4 Renaissance Drama
Twelve representative Elizabethan and Jacobean comedies and tragedies.

30.8F1 Seventeenth-Century Literature
Major prose and poetry of the seventeenth-century, excluding drama: Bacon, Hobbes, Browne, Bunyan, Donne, Herbert, Jonson, Marvell, and others.

30.8L1 Early American Literature
A survey of American literature during its first two centuries, from the Puritans to the Knickerbockers, from William Bradford to James Fenimore Cooper.

30.9E5 Shakespeare's Histories
The English history plays from *Richard III* to *Richard V,* plus *Titus Andronicus, Julius Caesar,* and *Troilus and Cressida.*

30.9E6 Shakespeare's Tragedies
Eight plays from *Richard II* to *Antony and Cleopatra.*

30.9E7 Shakespeare's Comedies
Eight plays from *Comedy of Errors* to *The Tempest.*

30.9E8 Problems of Shakespearean Interpretation
A study of various "problematic" plays; a general knowledge of Shakespearean drama and the sonnets is presumed.

30.9F6 Milton's Major Poetry
Milton's poetic and intellectual achievement is studied through analysis of his major works. Particular emphasis is given to *Paradise Lost* as an expression of Renaissance humanism and the culmination of the epic tradition.

GROUP IV

(three quarter hours required)

30.8G1 Restoration and Early Eighteenth-Century Literature
A critical study of neoclassical drama, poetry, and criticism; Restoration drama, Dryden, Pope, Addison, Steele, and Gay.

30.8G6 Age of Johnson
Johnson, Boswell, and the Club: Burke, Goldsmith, and Gibbon; poetry of Cowper, Gray, Burns, and Smart.

30.8J1 Victorian Literature
General survey touching upon major genres of Victorian literature with emphasis on the transition from the Victorian to the "modern," including such writers as Carlyle, Ruskin, the Brontes, Swinburne, Pater, Wilde.

30.8M1 Nineteenth-Century American Literature
A critical examination of selected works of prose and poetry by major writers of the period: Poe, Hawthorne, Melville, Thoreau, Dickinson, and Longfellow.

30.9G3 Topics in Augustan Literature
Subject to be announced.

30.9G7 Eighteenth Century Fiction
Novels by Defoe, Fielding, Richardson, Smollett, Sterne, and Austen.

30.9G8 Individual Eighteenth-Century Novelist
Subject to be announced.

30.9H1 Romantic Poetry I
A study of the first generation of British poets (Blake, Wordsworth, Coleridge) whose

concern for individual dignity and imaginative freedom came to be characterized as Romanticism.

30.9H2 Romantic Poetry II
Second generation of British Romantics: Byron, Keats, Shelley.

30.9H3 Topics in Romanticism
Romantic attitudes toward mankind in relation to self, society, and the universe, and Romantic attitudes toward the individual person as Poet, with the impact these attitudes have upon the form and thematic substance of authentic and fictional autobiography in poetry and prose. May include an intensive reading of one major British writer whose attitudes, themes, style, and philosophy are representative of the Romantic Era (1794–1832).

30.892 Victorian Poetry
A close study of Tennyson, Browning, Arnold; also the Pre-Raphaelite circle and the movement toward modernism: D. G. Rossetti, Swinburne, G. M. Hopkins.

30.9J7 Victorian Novel
Close study of major works by Dickens, Eliot, the Brontes, Hardy.

30.9J8 Individual Victorian Novelist
Subject to be announced.

30.936 Topics in Victorian Literature
Subject to be announced.

30.9L2 Literature of the Early Republic
The beginning of the American literary tradition in poetry, prose, fiction and drama: Freneau and Bryant, Bartram and Irving, Browne and Cooper, Tyler and Dunlap.

30.9M1 Nineteenth-Century American Transcendentalism
Subject to be announced.

30.9M2 Nineteenth-Century American Poetry
Subject to be announced.

30.9M7 The Romance in America
An attempt to define the American Romance through the study of Cooper's Leatherstocking novels, the major novels of Hawthorne, and Melville's *Moby Dick* and *Billy Budd*.

30.9M8 The Rise of Realism
An examination of Local Colorism, Realism, and Naturalism in the works of Twain, Howells, James, Dreiser, Norris, and readings in European Realism.

30.9P5 Literature of the American South
A study of the southern literary experience from early nineteenth-century to mid-twentieth, from Simms to Faulkner.

30.9P9 Individual American Writer
Subject to be announced.

GROUP V
(three quarter hours required)

30.8K1 Twentieth-Century British Literature
Theme and structure in the work of several dramatists from Shaw to Osborne and of several novelists from Conrad to Anthony Powell with an emphasis on major trends in the novel and in drama during the present century.

30.8N1 Twentieth-Century American Fiction
Adams, Dreiser, Crane, Dos Passos, Fitzgerald, Cozzens, Faulkner. The beginnings and development of modern American fiction.

30.9K1 Early Twentieth-Century British Poetry
Twentieth-century poets whose work has shaped and established the modern tradition or extended our understanding of the traditions of the past: Hardy, Yeats, Lawrence, Muir, Auden, Owen, Thomas.

30.9K2 Contemporary British Poetry
A seminar concentrating on the main currents in British poetry since 1945, including an examination of the later work of the poets of Auden's generation as well as such writers as Philip Larkin, Edwin Muir, William Plomer, A. D. Hope, Basil Bunting, and others, especially those younger writers whose work represents a break with established traditions.

30.9K3 Individual Modern British Poet
Subject to be announced.

30.9K4 Twentieth-Century Irish Renaissance
A study of the emergence of a distinctive Irish literary tradition through concentration on the work of the main figures of the Irish Literary Revival, with particular emphasis on Yeats, Joyce, Synge, and O'Casey; minor concentration is on post-Revolutionary and contemporary Irish writers: O'Faolain, O'Connor, and Behan.

30.9K7 Twentieth-Century British Fiction
Major figures of the modern and the contemporary periods: Conrad, Joyce, Cary, Beckett, Braine, Fowles, Snow, Lawrence, Woolf, Murdoch, Lessing, Huxley.

30.9K8 Individual Modern British Novelist
Subject to be announced.

30.9N1 Twentieth-Century American Poetry
Twentieth-century poets who have struggled to establish a tradition for American poetry and whose examples have dominated poetry up to the present: Robinson, Frost, Stevens, W. C. Williams, M. Moore, Eliot, Pound, Crane, Cummings, and the Fugitives.

30.9N2 Individual Modern American Poet
Subject to be announced.

30.9N3 Contemporary American Poetry
Subject to be announced.

30.9N7 Modern American Novel
Subject to be announced.

30.9N8 Individual Modern American Novelist
An in-depth examination of the work of a major figure in American fiction, focusing on the cultural context out of which he or she emerges. Recent selections for this course have been Hemingway, Fitzgerald, Mailer, Faulkner, and Bellow.

30.994 Modern American Drama
Philosophic and aesthetic trends among such playwrights as O'Neill, Williams, Miller, Albee, Simon, and others.

ELECTIVES

30.8B2 Children's Literature
A study of history and major forms of children's literature in the English language. The course covers such topics as folktales and folklore, novels, poetry, and informational books and includes cultural and sociological theories of childhod and adolescence.

30.9B1 Critical Schools
A seminar concentrating on one or several related recent developments in literary theory and criticism such as structuralism or post-structural criticism. The subject of the seminar changes from year to year.

30.9B3 English Prose Style
The development of prose style in English (chiefly expository), from the sixteenth century to the present. Most major authors are represented, from Roger Ascham to James Baldwin.

30.9B4 Short Fiction
The short stories of Sherwood Anderson and Ernest Hemingway and their contribution to American literature.

30.9B5 Comic Drama
The Comic Spirit and its manifestations in dramatic literature and performance. The nature and forms of comic playwriting from Aristophanes to the present. An examination of the theater's comic forms: farce, comedy, satire, parody.

30.9B6 Tragic Drama
This course considers important theories of tragedy and certain plays in an effort to consider the relation, if any, which exists between theory and practice of the tragic genre.

30.9B7 Theatrical Styles
An examination of modern dramatic expression and theory with particular attention to absurdist drama, existentialist drama, and Brecht's theatre of alienation.

30.9B8 Humor in American Literature
An account of American humorous writing from 1830 to the present. Various types of literary humorists are studied, such as Artemus Ward, Mark Twain, George Harris, and others. Some attention also to such modern humorists as Thurber.

30.9B9 Satire
A theoretical study of satiric forms—Roman, Renaissance and neoclassical verse satire, and later satiric narratives. Writers surveyed can include Horace, Juvenal, Pope, Swift, Voltaire, Byron, Evelyn Waugh.

30.9R1 Creative Writing I
Prose fiction.

30.9R2 Creative Writing II
Poetry.

30.8R4 Theory and Teaching of Writing
Designed for teachers or prospective teachers of writing in college or the public schools, this course examines several premises of writing instruction and how they can provide successful classroom practices.

30.9R3 Writing for the Professions
This course examines the various forms of business communications and offers practical experience in writing business letters, memoranda, case studies, proposals, and reports for students in the Graduate School of Business Administration.

30.9S2 Perspective on American Literature
An attempt to discover common themes and recurrent patterns in American literature through a close reading of critics as various in their approach as Lawrence, Parrington, Chase, Pearce, and Fiedler.

30.9S5 Literature and the Visual Arts
Examination of the complex relationships between literature and visual art. Consideration of such topics as theoretical approaches to this relationship, the work of painter-poets, verbal descriptions of art (e.g., poems about paintings), works in which verbal and visual art are integrated. The course is organized by issues rather than historically. Each student is expected to work on an individual project. Field trips are included as part of the course.

30.9S6 Problems in Writing
This course examines writing problems in general as well as those which are specific to professional interests.

30.963 Technical Writing
Technical writing assignments, including correspondence, description, instructions, proposals, and reports. Use of graphics, layout techniques, and visual aids. Emphasizes audience definition, editing, and rewriting.

30.937 Topics in Technical Writing
Writing assignments related to computers and the computer industry. Preparation of operator's manual and program documentation (instructions for running a program in a programming language such as BASIC or PASCAL). Experience in editing and revision and work with graphics and layout in preparing assignments.

30.9S7 Nineteenth-Century European Novel
Examination of major novelists and major literary movements in nineteenth-century Europe. Discussion of such novelists as Balzac, Stendahl, Huysmans, Flaubert, Dostoevski, Turgenev, and Hardy.

30.873 Classical Backgrounds
Readings in translation of Greek and Roman literature pertinent to the study of English and American literature. Focus upon the development of genre and theme.

30.9S8 Literature and Psychology
An examination of theoretical positions and practical problems in the relationships between literature and psychology. Psychological interpretations of lyrics, works of fiction, and dramas are examined. In addition to the selected essays on certain literary works, several theoretical texts are studied.

30.9S9 Literary Impressionism
Intensive study of the theory of Impressionism (with some attention to music and painting as well as literature) and its role in literary history. Readings explore French, British, Scandinavian, and American writers, especially Crane, Ford, Conrad, James, Moore, Hemingway, and Faulkner.

30.9Z1 Thesis
Six quarter hours maximum; by arrangement.

30.9Z2 Independent Study
By arrangement.

history

Professors

Raymond H. Robinson, Ph.D., Harvard University, Chairperson
Philip N. Backstrom, Jr., Ph.D., Boston University
William M. Fowler, Ph.D., University of Notre Dame
Donald M. Jacobs, Ph.D., Boston University
John. D. Post, Ph.D., Boston University

Associate Professors

Charmarie J. Blaisdell, Ph.D., Tufts University
Ballard C. Campbell, Ph.D., University of Wisconsin
Norbert L. Fullington, Ph.D., Harvard University
LaVerne J. Kuhnke, Ph.D., University of Chicago
Clay McShane, Ph.D., University of Wisconsin
Stanley R. Stembridge, Ph.D., Harvard University

Assistant Professors

Laura L. Frader, Ph.D., University of Rochester
Ruth-Ann M. Harris, Ph.D., Tufts University
Gerald H. Herman, M.A., Northeastern University
Martin R. Ring, Ph.D., Tulane University

THE MASTER'S DEGREE

Admission

Procedures and requirements are discussed on page 19. Applicants for the fall quarter who submit their application and all supporting documents by March 15 will be notified on or about April 1. Students who are interested in financial assistance must file all material by March 15.

Programs

Two programs are available for candidates for the Master of Arts degree.

Option I

This program is designed for those who are interested in pursuing careers in research, writing, and teaching, and requires forty-one quarter hours of academic work.

Students must take the following courses:

23.800 Methodology
23.801 European Historiography

Or
23.900 American Historians
Two courses specifically labelled "seminar," except that students writing theses need take only one seminar.

Students must complete 23.800 prior to enrolling in seminars, and grades of at least B must be obtained in the seminars.

Students must complete at least one course in each of three areas: Group 1, Europe; Group 2, United States; and Group 3, Other Areas.

Group requirements are not satisfied by the historiography courses, 23.801 and 23.900.

With the prior approval of the faculty adviser, a maximum of nine quarter hours may be elected from graduate courses in other departments and a maximum of twelve quarter hours may be elected from advanced undergraduate courses in history or related subjects.

A thesis is optional with the approval of the graduate committee. If approved, a thesis carries nine quarter hours of credit.

Option II

The second option, focusing on historical agencies and administration, is designed for those interested in careers outside the classroom.

The program requires forty-two quarter hours of academic work. The following courses are required:

23.800 Methodology
23.801 European Historiography
Or
23.900 American Historians
23.958 Historical Societies and Archives
23.994 and 23.995 Fieldwork in History I and II
One course specifically labelled "seminar."
Three of the following:

23.954 Media and History
23.955 Historical Administration
23.959 Oral History
23.960 Historical Exhibits and Museums
23.961 Historic Preservation
23.964 Historical Editing

The remaining twelve quarter hours are taken from the list of history graduate courses.

A brochure describing this second option in further detail is available by request from the Department of History.

Comprehensive Examination

All degree candidates must pass a written or oral comprehensive examination or satisfy an optional requirement specified by the Department.

Language Requirement

Degree candidates must demonstrate proficiency in a foreign language approved by the department, or, as an alternative option, in either computer programming or advanced statistics.

Financial Aid

In addition to teaching and tuition assistantships, the Department awards a scholarship in memory of Professor Robert A. Feer, a member of the Department of History from 1963 to 1970.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit except seminars which carry four quarter hours and other courses where noted.

23.800 Methodology
The objectives, methods, and resources of the historian.

23.801 European Historiography
The development of historical writing from ancient times to the present.

23.802 Ancient Greece (Group I)
Selected topics in the history of ancient Greece.

23.803 Ancient Rome (Group I)
Selected topics in the history of Rome in the period of the Republic or the Empire.

23.806 Intellectual History of Europe, 1688–1789 (Group I)
The broad spectrum of eighteenth-century thought, with emphasis on scientific, religious, and political ideas.

23.807 Intellectual History of Europe, 1789–1870 (Group I)
The great age of liberal and nationalistic thought. Social problems created by industrialism and various proposals to solve these problems are examined.

23.808 Intellectual History of Europe, 1870–1950 (Group I)
The intellectual developments which have brought Europe to its present position in world affairs. Topics considered include theories of evolution, scientism, radical socialism, and fascism.

23.809 Seminar in European Intellectual History (Group I)
Research and writing on special topics in European intellectual history.

23.813 Economic History of the Modern Western World (Group III)
Topical analysis of the economic development of the modern western world.

23.818 Seminar in the Renaissance (Group I)
Research and writing concerning the Renaissance.

23.819 Seminar in the Reformation (Group I)
Research and writing concerning the Reformation.

23.820 The Renaissance (Group I)
European political and cultural life from the thirteenth to the seventeenth centuries, with attention to Humanism and to the rebirth of classicism in literature and the arts.

23.821 The Reformation (Group I)
The development of the Christian Church from the thirteenth to the seventeenth centuries, with attention to the conflict between church and state, the impact of the Renaissance, the rise of the Protestant sects, and the wars of religion.

23.830 Britain, 1688–1815 (Group I)
Topics include constitutional evolution, political parties, social and economic change, religious and intellectual developments, cultural achievements, and Scotland and Ireland.

23.831 Britain, 1815–1914 (Group I)
Aspects of nineteenth-century Britain, including reform of parliament, liberalism and socialism, the Irish question, imperialism, and Victorian ideas and attitudes.

23.832 Seminar in Twentieth-Century Britain (Group I)
Selected topics for research and writing.

23.833 Seminar in Nineteenth-Century Britain (Group I)
Selected topics for research and writing with special emphasis on the social effects of industrialization.

23.834 Britain Since 1914 (Group I)
A social and political history with emphasis on the manner in which incompetent leadership and futile class struggle contributed to Britain's failure as a world power.

23.842 Seminar in Modern France (Group I)
Research, writing, and collective analysis of several themes in modern French social history since 1789, including the role of social class in revolutionary protest, industrialization, technology and modernization, the rise of the working class and the development of organized labor, the French peasantry in an industrial society, the nature of the family, and women's roles.

23.846 Seminar in European Social History (Group I)
Focusing on Britain, France, and Germany in the nineteenth and early-twentieth centuries and looking at history "from below," this course examines comparatively issues in European social history. Topics include the nature of social protest, the rise of organized labor, and the impact of war and revolution on the lives of ordinary people.

23.850 Seminar in Russian History (Group I)
A narrow period or special topic in Russian history. *The course presupposes a basic knowledge of Russian history and requires extensive work on a research paper.*

23.852 Seminar in Approaches to Women's History (Groups I, II, or III)
Study focuses on current issues in women's history and the methods historians use to

study women's historical roles in the market place, work force, political arena, and domestic scene in Europe, Asia, the United States, and Latin America. Emphasis is on the importance of comparative and interdisciplinary approaches to the history of women. The seminar includes lectures and discussions with specialists using various approaches, assigned reading, and an independent project.

23.855 Socialism and Revolution (Group I)
Studies in the history of socialism and revolution from the early nineteenth-century utopias to the New Left of the 1960s.

23.857 The Modernization of Ireland (Group I)
Analysis of themes in the growth and development of modern Ireland. Topics examined include migration and its effects on a traditional society, the role of religion in the assertion of national independence, and modernization within the British nexus.

23.860 Diplomatic History of Europe, 1815–1914 (Group I)
The foreign policies of the chief European powers, with emphasis on changing alliances and alignments, imperialistic rivalries, and efforts at international cooperation.

23.861 Seminar in Imperialism (Group I)
An inquiry into the motives underlying European expansion in the late nineteenth century.

23.862 Twentieth-Century Europe (Group I)
The political history of Europe since 1900, with attention to World War I, the rise of Communism and Fascism, the struggle for security in the western democracies, World War II, and the Cold War.

23.863 Seminar in Twentieth-Century Europe (Group I)
A study of a selected controversy in contemporary European History.

23.864 Hitler's Germany (Group I)
A study of the history of the Third Reich, including an in-depth analysis of the process by which the political motives and methods of the Nazis ultimately won the support of the German people.

23.872 Communism in China (Group III)
A study of the Chinese Communist movement from its origins in the 1920s to the present.

23.875 Modern Japan (Group III)
The history of Japan since the fall of the Tokugawa, emphasizing political and economic developments, especially after World War II.

23.883 History of the Islamic Peoples (Group III)
A study of the history, culture, and religion of the followers of Muhammad from 600 to 1800.

23.884 Modern Middle East (Group III)
A study of the Middle East in the twentieth century.

23.890 History of Exploration (Group III)
A comprehensive survey of exploration from ancient times to the present with emphasis

on the motives for exploration and their impact on the regions discovered and on those doing the discovering.

23.893 Family History (Group I or II)
An examination of the history of the family in Europe and America from the *ancien regime* to the present with attention to demographic issues and trends, industrialization and the family, women's roles, child-rearing practices, the changing nature of marriage and divorce, and life cycle and aging.

23.895 Approaches to World History (Group III)
An interdisciplinary examination of the study of civilization emphasizing various methodologies and theories and testing them by studying specific historical periods and cultures.

23.896 Psycho-History (Group III)
An introduction to the concepts, scholarship, problems, and directions of psychohistorical studies.

23.898 Population in History (Group III)
An application of demographic theory to history.

23.900 American Historians
The writing of American history by Americans, from colonial times to the present, with emphasis on changes in both form and substance.

23.905 Colonial America: The Seventeenth Century (Group II)
Exploration of the New World, settlement of the English North American mainland colonies, and the adaptation of European institutions and ideas to New World conditions.

23.906 Colonial America: The Eighteenth Century (Group II)
The expansion of the English colonies in the New World, the development of political and social institutions, and the sources of friction with England to 1763.

23.907 The American Revolution (Group II)
Topics in the history of the American Revolution from 1763 to 1783.

23.909 Seminar in Colonial and Revolutionary America (Group II)
Research and writing on some topic in American history prior to 1789.

23.912 American Social History, 1900-1950 (Group II)
The transformation of the naive and idealistic America of the early twentieth century to life in a world in which technology has far outstripped man's mental and moral capacity to cope with it.

23.919 Boston as a City (Group II)
An in-depth examination of historic Boston from 1822 to the present. Emphasis is on Boston's early growth as a city, the Hub as a center of pre-Civil War reform, the coming of the Irish, Boston as America's Athens, the revolutionary shift from Yankee to Irish political domination, the flamboyant era of James Michael Curley, and the development of the "New Boston."

23.920 Seminar in American Urban History (Group II)
The political, economic, and social history of America's major cities, with special emphasis on Boston's last century.

23.924 Topics in American Reform (Group II)
Selected studies of movements to change aspects of American society.

23.926 Seminar in American Maritime History (Group II)
Examination of selected aspects of American maritime history. Possible topics range from early exploration to the age of nuclear propulsion and may include merchant and naval aspects of the subject.

23.929 The Age of Roosevelt (Group II)
An analysis of the foreign and domestic policies and programs of the four Roosevelt Administrations, set within the context of the world-wide depression and global war. Emphasis is on the range of recent interpretations and analytic methods used in evaluating the place of Roosevelt in American history.

23.934 Seminar in American History (Group II)
Research and writing on selected aspects of American history.

23.935 Seminar in Recent American History (Group II)
Special topics from the period 1896 to 1960 studied in detail. Students are expected to present a research paper on a major person, action, or movement.

23.945 Topics in the Civil War and Reconstruction (Group II)
Analysis of key issues surrounding the events leading up to the Civil War, the war itself, and the Reconstruction period.

23.947 Public Life in Nineteenth-Century America (Group II)
Analysis of public policy and policy making; governmental structure, relations, and ideology; and electoral systems, viewed in long-run perspective.

23.948 Political Change in Twentieth-Century America (Group II)
Analysis of the growth of governmental function and structure, emphasizing the evolution and administration of leading policy concerns of the current century, changes in federalism and intergovernmental relations, and patterns of popular political participation and thinking.

23.949 Seminar in American Governmental History (Group II)
Concentrated attention to a particular problem or theme in American governmental history, emphasizing individual student research and writing.

23.954 Media and History (Group III)
Students will have the opportunity to explore such topics as the advantages and drawbacks of specific media, the uses and abuses of media in research and teaching, and the construction of media. Each student is required to participate in a research project involving the creation and/or evaluation of historically valid films, slide tapes, and other materials.

23.955 Historical Administration (Group III)
The administration of historical agencies with attention to problems of finance and personnel and to the legal-governmental environment in which agencies operate.

23.958 Historical Societies and Archives (Group III)
The varieties of historical societies (local, state, and national) and the kinds of private (business, college, church) and public (local, state, and national) archives; their activities and procedures; their similarities and differences.

23.959 Oral History (Group III)
The theory and practice of creating, processing, and using primary source material obtained by taping interviews with people whose role in history would otherwise go unrecorded.

23.960 Historical Exhibits and Museums (Group III)
Approaches, techniques, and special problems in the presentation of history to the public through exhibits, films, and other audiovisual and written media. Guest lecturers from the field present lectures, and students have the opportunity to gain practical experience.

23.961 Historic Preservation (Group III)
An introduction to historic preservation, with attention to the history, the philosophy, and the practical problems of preservation.

23.964 Historical Editing (Group III)
A laboratory for the study and practice of historical editing. Students are introduced to the major collections of edited papers and instructed in editing historical documents. Each student is given an historical document to prepare for publication. Instruction also covers the editing of history books and journals.

23.966 New Perpectives on American Slavery (Group II)
An in-depth examination of slavery in the Americas. Special emphasis will be placed on the impact of the slave trade; the development of slavery as an institution; the impact of slavery on the black family; the key role played by the black church; black resistance to slavery; the historiography of slavery, especially the two decades of reaction to the still controversial thesis of Stanley Elkins; and slavery from a comparative perspective, contrasting slavery in Latin America and the United States.

23.967 African-American History I (Group II)
The history of African-Americans to 1900, with emphasis on the role of black people in slavery and freedom.

23.968 African-American History II (Group II)
The history of African-Americans since 1900.

23.969 Seminar in African-American History (Group II)
Research and writing on an aspect of African-American history.

23.976 Canada and the United States (Group III)
How and why a separate Canadian nation managed to emerge despite decades of American political and military threats. Examination also includes Canada's subsequent response to growing cultural and economic domination by the United States.

23.981 Industrial Archeology (Group III)

23.982 Genealogical Research: Methods and Uses (Group III)

23.983 Local History Methodology (Group III)

23.990 Assigned Reading in History (1 q.h.)
Assigned reading under supervision of a faculty member.

23.991 Thesis (9 q.h.)
Thesis supervision by members of the Department.

23.994 Fieldwork in History (4 q.h.)
Fieldwork offers students the opportunity to get practical experience in historical agencies (including historical societies, archives, museums, exhibits, restorations, preservation projects, and the like). Students are required to work in the agency eight to ten hours a week for one quarter under the direction of an agency supervisor and departmental adviser.

23.995 Fieldwork in History (4 q.h.)
A second opportunity for students to acquire practical experience in a historical agency. The fieldwork placement requires eight to ten hours a week for one quarter under the direction of an agency supervisor and a departmental adviser.

law, policy, and society

Beginning in the 1982 fall quarter, the Graduate School of Arts and Sciences at Northeastern University is offering an interdisciplinary program in Law, Policy, and Society leading to the Doctor of Philosophy degree. Designed chiefly to help provide an interdisciplinary perspective on legal and social issues to individuals interested in social policy careers, the program is open to applicants who possess a master's degree in a social science or related field or have earned a law degree.

An optional program leading to the Master of Science degree in Law, Policy, and Society is also available to students who have already earned a J.D. or who are enrolled in the Northeastern University School of Law and wish to pursue a combined M.S./J.D. program of study.

Program Administration

The programs in Law, Policy, and Society are administered by a Graduate Coordinator appointed by the Dean of the College of Arts and Sciences. The Graduate Coordinator chairs the program Coordinating Committee, which consists of elected members from the College of Criminal Justice, School of Law, Boston-Bouvé College of Human Development Professions, and various departments within the College of Arts and Sciences. Advising, course development, thesis supervision, and other academic aspects pertaining to the program are responsibilities shared by faculty members affiliated with the program.

Admission

Students desiring admission to the Ph.D. program in Law, Policy, and Society must have completed a master's degree in a related discipline such as economics, sociology, criminal justice, or legal history or have a recognized law degree. The M.S. program is offered to qualified individuals who hold a recognized law degree, while the combined M.S./J.D. program is restricted to students accepted by Northeastern University's School of Law.

Applications to the program are considered for the fall quarter of each year. Application materials for the graduate programs in Law, Policy, and Society may be obtained from the Graduate School of Arts and Sciences, and application should be made directly to the Graduate Coordinator of the program. To be considered for admission, applicants must submit an official copy of transcripts indicating the award of prerequisite degrees as outlined above. In addition, a completed application, three letters of recommendation testifying to the student's ability to complete a graduate program, and official scores from the Graduate Record Examination (Aptitude Test only) or Law School Admissions Test are required. International students desiring admission to these programs should consult earlier sections of this bulletin for information about additional requirements applying to them.

All application materials must be received no later than March 15 of the spring preceding the fall quarter for which admission is requested. Materials

should be mailed to Law, Policy, and Society Graduate Coordinator, 301 Lake Hall, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115; however, official scores from the Graduate Record Examination (Aptitude Test only) or Law School Admissions Test should be forwarded to the office of the Graduate School of Arts and Sciences.

PH.D. PROGRAM IN LAW, POLICY, AND SOCIETY

Program

The program of study can be pursued on a full- or part-time basis provided that all coursework is completed within two academic years. At least thirty-three quarter hours of graduate work beyond the master's or law degree are required for the Ph.D. This work must include fourteen quarter hours of work in core requirements and a concentration comprised of nineteen quarter hours.

Core Course Requirements

The following courses comprise the core requirement:

		Q.H.
93.850	Law, Policy, and Society Survey	3
88.974	Legal Research and Process	3
39.9A1	Microeconomics	4
93.851	Critical Evaluation of Research	4

Students may petition the program Coordination Committee to waive the requirements for the Legal Research and Process and the Microeconomics courses by providing appropriate evidence of equivalent competency.

In fulfilling the core course requirements specified above, students are expected to demonstrate competence in statistical inference on a proficiency examination as a prerequisite to enrolling in the Critical Evaluation of Research course. Students who lack the required level of proficiency must take an appropriate course (e.g., 39.9E1, 21.813, 50.842) to make up the deficiency; however, credits earned in such a course may not be counted toward the minimum thirty-three quarter hours required for the degree.

Concentration Requirements

The bulk of the doctoral program curriculum in Law, Policy, and Society is organized within an area of concentration proposed by the student and developed in concert with a faculty adviser. A proposed concentration must be approved by the program Coordinating Committee and must bring several disciplinary perspectives to focus on one topical area of law, policy, and society studies. To fulfill concentration requirements, students must complete at least nineteen quarter hours of course work selected from related areas in at least three affiliated academic units (departments or colleges). Each concentration may comprise general electives, chosen from those listed below, as well as courses more narrowly related to the specific topical area of interest. General electives are courses that have been identified as potentially relevant to any concentration area.

Several specimen concentrations are provided for illustration, below; others may be proposed. Students choosing to follow one of the sample concentrations have the opportunity to make additional specific course suggestions, in concert with their advisers, that are appropriate to their backgrounds and goals.

Comprehensive Qualifying Examinations

After completing course requirements, each student must pass comprehensive qualifying examinations, consisting of two parts: 1) a four-hour written examination in the broad area of law, policy, and society, including relevant theoretical and methodological issues; and 2) a three-hour individual written exam or a "state-of-the-art" paper in the student's selected concentration area.

Degree Candidacy

Degree candidacy is established when students have completed the minimum number of quarter hours required for the degree and have passed the comprehensive qualifying examinations.

Language Requirement

Students are expected to demonstrate competency in one language, other than English, that is relevant to the study of Law, Policy, and Society. Students must submit their choice of language to the program Coordinating Committee for approval. A computer language may be permitted to fulfill this requirement.

Dissertation

An original doctoral dissertation is required of all doctoral students in accordance with the general regulations of the Graduate School of Arts and Sciences. The student's thesis adviser and at least one other member of the thesis committee must have affiliate status in the Law, Policy, and Society Program.

Final Oral Examination

In keeping with the academic requirements of the Graduate School of Arts and Sciences, doctoral candidates must also pass a final oral examination on the subject explored in their doctoral dissertation, including significant developments in the field covered in the dissertation.

This examination is taken after the student has completed all other degree requirements and must be held at least two weeks prior to the commencement at which the degree is to be awarded.

M.S. PROGRAM IN LAW, POLICY, AND SOCIETY

Students accepted to the M.S. program or the combined M.S./J.D. program must complete a minimum of forty quarter hours of graduate work, consisting of the fourteen quarter hours of core course requirements and twenty-six quarter hours of concentration requirements as outlined for the doctoral program. Stu-

dents in the combined M.S./J.D. program may transfer no more than seven quarter hours of law school course work for credit toward the degree.

In addition to course requirements, students must pass the first part of the qualifying examinations described above to fulfill the requirements for the Master of Science degree in Law, Policy, and Society.

DESCRIPTION OF COURSES

Core Courses

93.850 Law, Policy, and Society Survey (Interdisciplinary, 3 q.h.)
This course is intended to offer students the opportunity to form a foundation derived from several disciplines in the range of methodologies and perspectives that are employed in the study of law and society. Among topics to be examined are issues such as normative vs. formative functions of law, social control vs. individual freedom, and legal bases of conflict management in society. Although the course is coordinated by one instructor, faculty affiliates of the program participate in the course, permitting approaches and specific content to be presented by and discussed from a variety of informed perspectives.

88.974 Legal Research and Process (Law, 3 q.h.)
This course is designed to offer an inside view of the American legal system and the structural relationships among its constituent elements, including the courts, legislatures, administrative agencies, and attorneys for private parties. It also offers a flavor of legal analysis and argumentation.

39.9A1 Microeconomics (Economics, 4 q.h.)
This course addresses the basic question of resource allocation within our society, a question central to issues concerning the appropriate role of government intervention in the private economy, the efficiency and equity of public expenditure-regulation programs, and the costs imposed on society by various activities that are unregulated or uncontrolled. A more detailed description of this course can be found in this catalogue under the Description of Courses for the Economics Department.

93.851 Critical Evaluation of Research (Interdisciplinary, 4 q.h.)
This course examines existing research in several disciplines on the subject of law, policy, and society, critically comparing and evaluating the methodologies employed in these studies. Both qualitative and quantitative techniques are introduced and discussed, and the techniques, advantages, and limitations of various research designs are explored. While specific techniques for discussion vary from quarter to quarter, focus consistently centers on practical research tools, including analysis of variance, co-variance, and multiple-regression techniques as applied to data bases derived from questionnaire, observation, and experiments. A knowledge of intermediate statistical methods is presumed of students entering the course.

General Elective Courses

The following general elective courses are recommended as being potentially relevant to any concentration area. Unless otherwise indicated, all courses carry three quarter hours of graduate credit. Students should consult other sections of this bulletin and the current bulletin of the Graduate School of Criminal Justice to obtain complete course descriptions.

20.852 The Anthropology of Law and Conflict
21.814 Multiple Regression in Sociological Analysis
21.887 Sociology of Policy, Planning, and Evaluation
21.940 Social Control I
21.941 Social Control II
21.837 Sociology of Law
21.847 Formal Organizations: Administration and Structure
21.916 Seminar in Qualitative Analysis I
21.917 Seminar in Qualitative Analysis II
22.822 American Constitutional Law
22.823 American Constitutional Law II
39.9M1 Intergovernmental Fiscal Relations
39.9E7 Introduction to Econometrics
39.9E8 Econometrics II
39.9F1 Seminar in Microeconomic Policy and Planning
92.860 Conflict Management

SUGGESTED MODEL CONCENTRATIONS

The following model concentrations, including suggested course work, are provided to illustrate the kinds of programs students may wish to design. The specific selection of course work in any area, however, may be determined by the student and an academic adviser. Typically, a concentration consists of six or seven courses.

The appropriate graduate school bulletin should be consulted for complete descriptions of courses suggested for model concentrations. Some courses offered by the Graduate School of Business Administration are among those suggeted for specific areas. Students wishing to enroll in these courses should seek the permission of the Director of the Graduate School of Business Administration.

ENVIRONMENTAL PROTECTION

The social and legal implications of environmental management make up one of the more complex groups of issues confronting our society. A concentration in this area would focus on impacts of technology on the environment—noise, chemical pollution, and conservation—and the influence of the environment on individual and social well-being, particularly as these influences are mitigated by law.

Suggested Course Work

Biology

18.847 Environmental Law

Economics

39.9K4 Externalities
39.9L7 Economics of Intercity Transportation
39.9L5 Economics of Urban Transportation

Engineering

01.207 Technology Assessment

Political Science

22.877 Environment and Energy Policy

Law

88.805 Property
88.900 Administrative Law
88.920 Environmental Law

Sociology

20.860 Cultural Ecology

LEGAL ISSUES IN HEALTH CARE

This concentration reflects an increasing concern with health-related issues. Encompassing the legal and social ramifications of such topics as access for the handicapped, rights of medical consumers, health-care regulation, nationalized medicine, and euthanasia, this concentration is designed to foster an interdisciplinary perspective on the many legal issues involving health-care delivery in our society.

Suggested Course Work

Economics

39.9H1 Economics of Medical Care and Health Manpower

Education

56.952 Program Development in Rehabilitation
56.958 Social Welfare and Rehabilitation
56.964 Legal Aspects of Rehabilitation and Special Education

Engineering

05.860 Health Care Organization and Management

Business

45.975 Introduction to Health-Care Systems
45.984 Health Systems Planning and Regulation

Political Science

22.868 Health-Care Administration

Law

88.973 Welfare
88.955 Involuntary Commitment of the Mentally Ill

Sociology

21.822 Sociology of Poverty
21.824 Sociology of Alcoholism

LEGAL ISSUES IN HUMAN RESOURCES UTILIZATION

Legal issues in human resources utilization range from more traditional problems of fair labor practices and union/management roles and conflicts to more recent problems centering on equal opportunity and affirmative action. This concentration permits examination of these issues as well as questions concerning appropriate education and training policies. The focus in this area of study is on legal issues, social consequences, and social responsibility with respect to these problems.

Suggested Course Work

Economics

39.9G1 Economics of Labor Market and Labor Force
39.9G7 Human Resources and Labor Problems and Policies
39.9W3 Human Resources Planning at State and Local Areas
39.9W5 Economics of Education and Training Programs

Education

50.823 Education and Equality

Business

45.972 Labor Relations
45.993 Labor Law

Political Science

22.899 Public Policy Issues in Human Services
22.908 Manpower Policy and Administration
22.977 Labor Relations in Public Administration
22.918 Civil Liberties in Public Administration
22.975 Equal Opportunity in Public Administration

Law

88.932 Labor Law I
88.934 Labor Law II

Sociology

21.861 Sociology of Prejudice and Discrimination
21.851 Sociology of Work
21.850 Sociology of Occupations and Professions

SOCIAL POLICY AND DEVIANT BEHAVIOR

The parallel problems of crime and deviant behavior have given rise to a vast network of public and private organizations, while calling forth a wide range of policies that influence both public and private behavior. Concentrating in this area involves an examination of the nature of crime and deviant behavior and the legal and social foundations of policy affecting criminal justice. It should be of value to the scholar interested in exploring the basis of deviance and the role of the criminal justice system, as well as to the administrator who seeks a better foundation for decisions in the criminal justice area.

Suggested Course Work

Criminal Justice

Crime Sequence
92.841 Criminal Law
92.843 Juvenile Law

Deviant Behavior Sequence
92.866 Theories of Delinquency
92.907 Theories of Criminology
92.908 Comparative Criminology
92.864 Criminal Behavior Systems
92.863 Organized Crime
92.842 Terrorism

Sociology

Crime Sequence
21.832 Sociology of Crime and Justice
21.827 Sociology of Delinquency
21.835 Theories of Criminology

Deviant Behavior Sequence
20.831 Culture and Mental Illness
21.820 Sociology of Deviant Behavior
21.824 Sociology of Alcoholism

Law

Crime Sequence
88.958 Juvenile Law
88.981 Prisoners' Rights

Deviant Behavior Sequence
88.955 Involuntary Commitment of the Mentally Ill

Economics

Crime Sequence
39.9K5 Economics of Crime

Education

Deviant Behvior Sequence
50.807 Abnormal Psychology
56.833 Mental Health

Psychology

Crime and Deviant Behavior Sequence
19.821 Behavioral Change in Institutions
19.822 Psychopathology I
19.823 Psychopathology II

mathematics

Professors

Maurice E. Gilmore, Ph.D., Univeristy of California, Berkeley, Chairperson
Samuel J. Blank, Ph.D., Brandeis University
Bohumil Cenkl, D.Sc., Charles University, Prague, Czechoslovakia
David I. Epstein, Ph.D., New York University
Holland C. Filgo, Jr., Ph.D., Rice University
Alberto R. Galmarino, Ph.D., Massachusetts Institute of Technology
Arshag Hajian, Ph.D., Yale University
Evelyn F. Keller, Ph.D., Harvard University
Nancy Kopell, Ph.D., University of California, Berkeley
Richard A. Rasala, Ph.D., Harvard University
Jayant M. Shah, Ph.D., Massachusetts Institute of Technology
Gabriel Stolzenberg, Ph.D., Massachusetts Institute of Technology
Harold Stubbs, Ph.D., Boston University
Jack Warga, Ph.D., New York University

Associate Professors

Shirley A. Blackett, M.Ed., Pennsylvania State University
Mark Bridger, Ph.D., Brandeis University
Gail A. Carpenter, Ph.D., University of Wisconsin
John Casey, Ph.D., Brown University
Agnes Chan, Ph.D., Ohio State University
Bruce Claflin, M.S., Northeastern University
Ellen H. Dunlap, B.A., University of California, Berkeley
Harriet J. Fell, Ph.D., Massachusetts Institute of Technology
John N. Frampton, Ph.D., Yale University
Samuel M. Giveen, M.A., Harvard University
Eugene H. Gover, Ph.D., Brandeis University
Anthony Iarrobino, Ph.D., Massachusetts Institute of Technology
Nishan Krikorian, Ph.D., Cornell University
Richard D. Porter, Ph.D., Yale University
Mark B. Ramras, Ph.D., Brandeis University
Betty J. Salzberg, Ph.D., University of Michigan
Thomas O. Sherman, Ph.D., Massachusetts Institute of Technology
Victor R. Staknis, Ph.D., Boston University

Assistant Professors

John Cade, Ph.D., University of Massachusetts, Amherst
Margaret Cozzens, Ph.D., Rutgers University
Lenore Feigenbaum, Ph.D., Yale University
Terence Gaffney, Ph.D., Brandeis University
Laurence S. Gillick, Ph.D., Massachusetts Institute of Technology
Mark Goresky, Ph.D., Brown University
J. Joseph Guay, Ph.D., University of Wisconsin
Samuel Gutmann, Ph.D., Massachusetts Institute of Technology

John Henze, Ph.D., Northeastern University
Paul Holley, M.S., Tufts University
Solomon M. Jekel, Ph.D., Dartmouth College
Donald R. King, Ph.D., Massachusetts Institute of Technology
Miroslav Klun, Ph.D., State University of New York, Buffalo
Robert C. McOwen, Ph.D., University of California, Berkeley
Michael Perloff, Ph.D., Stanford University
Vera K. Proulx, Ph.D., Columbia University
Catherine Roche, Ph.D., Northeastern University
Martin Schwarz, Jr., Ph.D., Courant Institute
Mark D. Stewart, Ph.D., Rice University
Michael Weiss, Ph.D., Rutgers University

Admissions Requirements

Applicants for admission must satisfy the admission requirements listed on page 19. In addition, they should have a background which includes courses in linear and modern algebra, mathematical analysis, and computer programming.

Students who have deficiencies in these areas may be accepted if their overall college work is judged satisfactory. However, they will be expected to learn the material during the first two quarters. Some of the courses may be taken at Northeastern University during the summer preceding enrollment. Students may also choose to enroll in the introductory courses or make individual arrangements with their advisers.

THE MASTER OF SCIENCE DEGREE

Three options are available to students enrolled in the Master of Science Degree Program.

A. Full-time Program in Applied Mathematics with Option of Employment in Industry

The Mathematics Department offers a special curriculum leading to a Master of Science degree in mathematics with emphasis on applied mathematics. The program includes an *optional* six-month period of employment in industry in a position requiring mathematics or computer science. (Industrial employment cannot be guaranteed nor is it required for graduation.)

Qualified applicants are eligible for teaching assistantships or tuition assistantships. (See page 31 for details.)

Employment in Industry

Northeastern University is well known as a pioneer and leading participant in cooperative education, a plan through which students alternate work and study. The University's Cooperative Education Department assists the Applied Mathematics Committee in obtaining internship positions.

Many students currently enrolled in the program hold full-time jobs in the

Boston area. Nearly all graduate courses in the Mathematics Department meet after 5:00 p.m., Monday to Thursday, so that students who work during the day may take one or two courses per quarter at night.

Course Requirements

Twelve graduate courses are required for the degree.

Four required courses:

- Data Structures
- Computer Organization and Programming
- Analysis I
- Algebra I

Five of the following:

- Statistics I
- Probability I
- Combinatorial Theory
- Applied Mathematics I
- Applied Mathematics II
- Numerical Analysis I
- Complex Analysis
- Measure and Integration
- Elective (subject to approval)

Three advanced courses in one of the following specialties:

- Computer Science
- Probability and Statistics
- Combinatorics

A student and adviser may also design a specialty in a field such as mathematical physics, classical applied mathematics and differential equations, or biomedical statistics. Certain courses in other departments may be included as part of the specialty program.

B. Full-Time Program

Forty-eight quarter hours of graduate credit are required for the degree.

Course Requirements

The following courses are required:

10.9A1, 10.9A3, 10.9A6	Analysis I, II, III
10.9A2, 10.9.A4	Algebra I, II
10.9A5, 10.9A7	Topology I, II
10.9F6	Computer Organization and Programming

In addition, each student must select four courses from the graduate mathematics offerings or from offerings in other departments carrying graduate credit. The selection of the elective courses must be approved by student's faculty adviser.

After completing the M.S. degree, a student with an excellent academic record may apply for admission to Northeastern's Ph.D. program in mathematics.

C. Part-Time Program

Students in this program may progress according to their abilities and available time, subject, of course, to the time limitation established by the Graduate School of Arts and Sciences. Students who are deficient in any of the mathematics courses required for admission to the degree program are required to satisfy their deficiencies by taking courses given for this purpose. Such courses carry graduate credit, but that credit is regarded as additional to regular degree requirements. Requirements for the part-time program are the same as those for a full-time program (either A or B).

Other Requirements

There are no comprehensive examinations and no language requirements for the M.S. degree.

THE DOCTOR OF PHILOSOPHY DEGREE

Admission

Students who have completed the full-time master's degree program or who have obtained a master's degree at another institution are eligible for admission to the doctoral program. Students who wish to earn the doctor's degree should inform the chairperson of the graduate committee of their desire to be doctoral candidates. Those who have been accepted as doctoral candidates will remain in that category as long as their progress is deemed satisfactory.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Course Requirements

The course requirements, in addition to the minimum master's degree requirements of forty-eight quarter hours credit, are established by the departmental graduate committee for each candidate. In most cases, thirty-two quarter hours of additional work are required.

Independent Work

Before starting their dissertation, doctoral students may be required to do an independent project, possibly, but not necessarily, in conjunction with departmental seminars or courses. The aim of the project is to start students on inde-

pendent work and to give them a practical way to learn research techniques. The M.S. Thesis is acceptable, for example.

Minor Specialty

Each doctoral candidate selects some specific mathematical subject of an advanced nature, which must be reasonably unrelated to the topic of the student's dissertation. By means of reading, lecture courses, and/or seminars, the student should render work in this area equivalent to a good part of one full year's course work (twelve quarter hours). Approval of the area and the plan of work should be obtained in advance from the department graduate committee.

Language Requirements

Ability to read and translate mathematical texts and journals in two foreign languages must be established by the candidate. The languages may be chosen from French, German, and Russian; any other choice requires special approval. Students should notify the chairperson of the departmental graduate committee when they are prepared to be examined on each language. The examinations are conducted by members of the faculty of the Mathematics Department.

Teaching Requirement

Some teaching experience is required. This requirement may be satisfied by at least one year of service as a teaching assistant or by suitable teaching duties.

Dissertation

After the successful completion of their independent work, when required, students select a dissertation adviser under whose guidance they write their doctoral dissertations. They may be assisted by the departmental graduate committee in that selection if they wish. The dissertation itself must represent an original solution of a problem in the chosen area of mathematics which makes some contribution to mathematical knowledge.

Final Oral Examination

The final oral examination on the dissertation is held in accordance with the Graduate School regulations.

DESCRIPTION OF COURSES

The following courses are offered for those who wish to enter the master's degree program in mathematics, but who fail to satisfy the admission requirements. These courses are taken in addition to the required course work in mathematics.

10.8B1, 10.8B2, 10.8B3 Abstract Algebra I, II, III (2 q.h.)
Groups, subgroups, normal subgroups, rings, ideals, integral domains, and fields. *Prep. Differential and Integral Calculus.*

10.8B4 Advanced Calculus I (2 q.h.)
Functions of one independent variable; limits, continuity, differentiality. Properties of continuous functions on a closed bounded interval. Rolle's theorem and the mean-value theorem. *Prep. Differential and Integral Calculus.*

10.8B5 Advanced Calculus II (2 q.h.)
Functions of several independent variables. Distance and open sets; limits, continuity. Properties of continuous functions on a closed bounded set. Differentiability and differentials, mean-value theorem, implicit function theorems, Jacobians and transformations. *Prep. 10.8B4.*

10.8B6 Advanced Calculus III (2 q.h.)
Sequences, sequences of functions, uniform convergence, series. Integration, line and surface integrals. *Prep. 10.8B5.*

The following courses may be used toward the degree requirements in mathematics.

10.8H3 Biostatistics (2 q.h.)
Methods of statistical inference with applications to biology and the medical sciences.

10.8K2 A First Course in Mathematical Logic (2 q.h.)
Propositional calculus, quantificational logic, first order theories through the Skolem-Lowenheim Theorem.

10.8K3 An Introduction to Recursive Function Theory (2 q.h.)
Turing machines. Partially computable functions. Primitive recursive and general recursive functions and predicates. Unsolvable decision problems. Recursively enumerable sets of integers. The unsolvability of Hilbert's Tenth Problem.

10.8K4 Godel's Incompleteness Theorem (2 q.h.)
Formal number theory. Arithmetization. Godel's First and Second Incompleteness Theorems for formal number theory. *Prep. A knowledge of the methods of mathematical logic.*

10.8K5 Set Theory (2 q.h.)
The informal study of sets, including detailed discussion of the axiom of choice, well-ordered sets, and transfinite arithmetic.

10.8K6 Formal Set Theory (2 q.h.)
Versions of axiomatic set theory. The consistency of the continuum hypothesis and the axiom of choice. As time permits, the independence of the continuum hypothesis and the axiom of choice. *Prep. the equivalent of 10.8K2 and 10.8K5.*

10.9A1 Analysis I (4 q.h.)
Basic topis in analysis and topology, including metric spaces and normed linear spaces; continuity; compactness; completeness; differentiability; function spaces; polynomial approximations. *Prep. Advanced Calculus.*

10.9A2 Algebra I (4 q.h.)
Emphasis on group theory and linear algebra, including definition of rings and modules. Groups: subgroups, cyclic groups, cosets, Lagrange's Theorem, normal subgroups, homomorphisms and automorphisms, permutations (cycle decomposition, parity, conjugacy classes). First and second isomorphism theorems, class equation, Sylow subgroups, direct products, finitely generated abelian groups. Linear algebra: bases and dimension, correspondence between linear transformations and matrices, systems of linear equations, row reduction, rank, determinant inner products. Gram-Schmidt; dual spaces; eigenvalues and eigenvectors; characteristic polynomial; minimal polynomial; spectral theorem for symmetric, hermitian, and unitary matrices.

10.9A3 Analysis II (4 q.h.)
Complex function theory, including the method of residues; evaluation of series and integrals; differential forms.

10.9A4 Algebra II (4 q.h.)
Finite extensions of fields, automorphisms, structure of finite fields, normal and separable extensions, Galois group, Fundamental Theorem of Galois Theory, cyclotomic fields, solvability of equations by radicals.

10.9A5 Topology I (4 q.h.)
General topological spaces. Compactness and connectedness. Separation properties. Products. Complete metric spaces. Baire category theorem. Quotient spaces. Function spaces. Elementary homotopy. Some of the functorial viewpoint.

10.9A6 Analysis III (4 q.h.)
Lebesque measure and integration, convergence theorems. Applications to probability theory and Fourier series.

10.9A7 Topology II (4 q.h.)
Simplicial complexes, manifolds. Classification of surfaces. Orientation. Euler characteristic. Vector fields. Mod 2 degree of a map. Linear group manifolds. Fundamental groups, covering spaces. Seifer-Van Kampen Theorem. Fundamental group of surfaces.

10.9B3 Constructive Algebra (4 q.h.)
A constructive development of some of the old familiar areas of algebra: principal ideal domains, Dedekind domains, factorial domains, Noetherian rings.

10.9B4 Set Theory (4 q.h.)
First part: Informal study of sets, including detailed discussion of the axiom of choice, well ordered sets, and transfinite arithmetic. Second part: versions of axiomatic set theory. The consistency of the continuum hypothesis and the axiom of choice. As time permits, the independence of the continuum hypothesis and the axiom of choice.

10.9B7, 10.9B8 Philosophy of Science and Mathematics I, II (4 q.h. each)
Topics may vary from year to year. Past subjects have included the foundations of statistical inference, the structure of scientific theories, and analysis of the conceptual structure of mathematics.

10.9B9 Seminar: Constructive Mathematics (4 q.h.)

10.9C1 Functional Analysis (4 q.h.)
Topological vector spaces, Banach spaces, Hilbert spaces, algebras of operators, representations.

10.9D1 Applied Mathematics I (4 q.h.)
Deterministic models in the physical and life sciences. Regular and singular perturbation: dimensional analysis; linear and nonlinear boundary layer problems; WKB theory; multiple scale analysis; qualitative analysis in phase science; singular perturbation of PDEs, asymptotic analysis.

10.9D2 Applied Mathematics II (4 q.h.)
Partial differential equations and modeling. Method of characteristics; shock waves; conservation laws; Fourier series; parabolic, hyperbolic, and elliptic equations; generalized Fourier transforms; first order systems; the Cauchy-Kowalewski theorem; well-posed problems; recent applications to scientific problems.

10.9E1, 10.9E2 Ordinary Differential Equations I, II (4 q.h. each)
Topics in ordinary differential equations. *Prep. Elementary Ordinary Differential Equations.*

10.9E8 Numerical Analysis I (4 q.h.)
Solution to boundary value problems by the finite-element method; formulation of finite elements; application to interpolation, elliptic and parabolic differential equations, and eigenvalue problems; numerical solution of problems on a computer.

10.9E9 Numerical Analysis II (4 q.h.)
Initial value problems: Runge-Kutta and multi-step methods; finite differences and finite elements.

10.9F1 Optimal Control Theory I (4 q.h.)
Linear and nonlinear control problems defined by ordinary differential equations, relaxed controls, existence theorems, Pontryagin's maximum principle.

10.9F3 Optimization (4 q.h.)
Convex sets, linear and nonlinear programming, zero-sum games, dynamic programming, numerical methods.

10.9F6 Computer Organization and Programming (4 q.h.)
Computer organization; hardware and software components. Memory organization and addressing. Machine representation of data. Machine language and assembly programming. Subroutines and macros. Students are required to program several short exercises in assembly language and to undertake a term project at the end of the course.

10.9F7 Data Structure (4 q.h.)
Basic structure for representing and manipulating data in computer programming: arrays, lists, stacks, queues, deques, trees, binary trees. Applications to nonnumeric computations. Searching and sorting. Students are required to write programs to implement these structures on a computer.

10.9F8 Compilers (4 q.h.)
Study of compilers; finite automata and lexical analysis; syntax specification; parsing;

syntax-directed translation; symbol tables; run-time storage administration; error detection and recovery; code optimization, code generation. Students work as a team on a large programming project. *Prep. knowledge of assembly language programming and some knowledge of data structures.*

10.9F9 Systems Programming (4 q.h.)
Batch systems programs: assemblers, loaders, macro processors. I/O programming. Multiple processors and interrupt mechanisms. Addressing techniques and memory management. Processor management and job scheduling. Device management. Information management: file access, protection, and maintenance. *Prep. 10.9F6, 10.9F7, or equivalent.*

10.9G1 Probability I (4 q.h.)
Introduction to probability; independent random variables; types of convergence; laws of large numbers; characteristic functions, central limit theorem.

10.9G2 Probability II (4 q.h.)
Introduction to stochastic processes; random walk; conditional expectations; Markov processes; multivariate normal distribution; Brownian motion.

10.9H1 Statistics I (4 q.h.)
Parametric families of distributions; testing hypotheses; likelihood ratio tests; estimation and maximum likelihood; regression.

10.9H3 Statistical Decision Theory (4 q.h.)
Subjective probability-utility. Bayesian approach to decision problems, including estimation, testing hypotheses, and linear statistical models. Sequential decisions.

10.9H4 Analysis of Variance (4 q.h.)
One-sample and two-sample tests; one-way ANOVA; factorial and nested designs; Cochran's theorem; regression; analysis of covariance; simultaneous confidence intervals.

10.9H5 Topics in Statistics (4 q.h.)
Topics to be selected from multivariate statistics and clustering; categorical data; biostatistics; Stein's paradox and admissibility; foundations. May be repeated for credit.

10.9H7 Applied Statistics (4 q.h.)
Level of measurement, central tendency, dispersion, relatedness and significance of differences, analysis of data through correlation, regression, F-test, Chi square tests, T-test, analysis of variance and analysis of covariance. These analyses are accomplished using computer-based statistical subroutine packages. *Not for Math graduate credit.*

10.9H9 Readings in Statistics and Probability (up to 4 q.h. per quarter)

10.9K4 Mathematical Logic (4 q.h.)
This course combines material of 10.9K2 and 10.8K4.

10.9M5 Lie Theory (4 q.h.)
Lie groups and Lie alebras. The exponential map. Examples, basic structure theorems. Representation theory. Applications. Additional topics vary with the instructor and may include infinite-dimensional Lie algebras, algebraic groups, finite groups of Lie type, geometry and analysis of homogenous spaces.

10.9N3 Calculus of Variations (4 q.h.)
Euler's equation for extremals: classical examples, isopenmetric problems; necessary and sufficient conditions for an extremal to be a local minimum; applications to differential geometry, physics, and economics, Hamilton-Jacobi Theory, theory of the second variation.

10.9O0 Introduction to Computer Programming and Applications (4 q.h.)
This course is intended for graduate students in sciences, social sciences, and humanities who need to understand how computers can help solve problems in their fields of study. After instruction in the basics of computer programming and algorithm development, students are introduced to examples of the computer's use in different areas of human endeavor. Students are required to write programs in BASIC programming language and run them on a computer. *This course cannot be taken for credit by graduate students in the Mathematics Department.*

10.9O1 Data-Base Management (4 q.h.)
Components of data base. Hierarchical, network, and relational data-base systems. DBMS facilities: schema, subschema implementation considerations. Privacy, security, integrity, concurrency. Data directors. Distributed data bases. Comparison of available data-base management systems. *Prep. A course in data structures.*

10.9O3 Concurrent Programming (4 q.h.)
Programs that have several parts in execution at the same time: the logical problems that arise and their machine implementations. Mutual exclusion, message passing, deadlock, monitors, kernels, and applications to operating systems. Programming is in the highest-level language available that supports concurrency.

10.9O9 Readings in Computer Science (up to 4 q.h. per quarter)

10.9Q1 Homological Algebra (4 q.h.)
Basic properties of categories and functors; sums, products, morphisms; Hom, Tensor Product, and their derived functors Ext and Tor; exact sequences, homology and cohomology; homological dimension and co-dimension; applications to algebra and topology.

10.9Q2 Commutative Algebra (4 q.h.)
Prime ideals, localization, integral extensions; primary decomposition; Krull dimension; chain conditions, Noetherian and Artinian modules: additional topics from ring and module theory as time permits.

10.9R1 Theory of Automata and Formal Language (4 q.h.)
Finite-state machines and regular expressions, context-free grammars. Parsing of context-free languages. Context-sensitive grammars, push-down stores, stock machines, and linear-bounded automata. Turing machines, undecidability, description of computation using list-structures, program machines, and programs.

10.9R2 Artificial Intelligence (4 q.h.)
Analysis of current computer programs dealing with problems such as theorem proving, chess playing, general problem solvers, robotics, symbolic computation, preceptions, self-reproducing automata, and parallel machines. *Prep. A course in data structures.*

10.9R5 Computer Communications System (4 q.h.)
Examples of networks such as ARPA and TYMNET: link problems such as ARQ multiplexing and protocols; Queuing theory; routing problems; flor-control and cryptography. *Prep. A course in probability and statistics.*

10.9R7 Combinatorial Theory (4 q.h.)
Various techniques of enumerative combinatorics, including binomial and multinomial theorems, principle of inclusion-exclusion, recurrence relation, generating functions. Stirling numbers. Special topics such as distributions, partitions, and polycounting theory are also covered. Topics in Matching Theory, including Hall's theorem. Marriage Problem and Rado's Selection Principle.

10.9R8 Combinatorial System Analysis (4 q.h.)
Topics of combinatorial analysis closely related to computer and other finite systems. These include t-designs, athogonal Latin Squares. Difference sets and finite geometries. Algebraic coding is studied, including cyclic codes, Reed-Solomon Codes, BCH Codes, and Reed-Muller codes. *Prep. One year of abstract algebra.*

10.9R9 Graph Theory (4 q.h.)
Graphs and subgraphs; trees; connectivity; Euler tours and Hamilton cycles; matchings, edge colorings; independent sets and cliques; vertex colorings; planar graphs; directed graphs; networks; the cycle space and bond space.

10.9S5 Algorithms and Complexity Theory (4 q.h.)
Data structures designed for efficient algorithms and for set manipulation problems such as lists, queues, stacks, binary search trees, and balanced tree schemes; algorithms on graphs such as depth-first search, path-finding problems; matrix multiplication, fast Fourier Transforms, NP-complete problems, and some intractable problems. *Prep. 10.9R7 Combinatorial Theory.*

10.9T1 Algebra III (4 q.h.)
Rings, ideals, factor rings, prime and maximal ideals, principal and ideal domains, polynomial rings, unique factorization and Gauss' Theorem, modules, Hilbert Basis Theorem, Noetherian rings and modules, Artin rings, matrix rings, Wedderburn's structure theorem for simple Artin rings, exact sequences, tensor products.

10.9U1 Algebraic Topology (4 q.h.)
Topics from homology groups, sequences; fiber spaces; sheaves; products in homology and cohomology; cohomology algebra; Kunneth theorems; cohomology operations; Poincare duality; higher homology groups and the Hurewicz theorem; characteristic classes, spectral sequences.

10.9U4 Differential Geometry (4 q.h.)
Geometry of surfaces in the euclidean space, with emphasis on the global aspects, using the technique of tensor calculus. Elements of Riemannian geometry, connections. Holonomy.

10.9W1 Dynamical Systems (4 q.h.)
Structural stability and qualitative theory of dynamical systems.

10.9W9 Seminar: Dynamical Systems (up to 4 q.h.)
Topics in dynamical systems as chosen by participants.

10.9Z2 Readings in Analysis (up to 4 q.h. per quarter)

10.9Z3 Readings in Algebra (up to 4 q.h. per quarter)

10.9Z4 Readings in Topology (up to 4 q.h. per quarter)

10.9Z5 Doctoral Dissertation

10.9Z6 Seminar in Analysis (up to 4 q.h. per quarter)

10.9Z7 Seminar in Algebra (up to 4 q.h. per quarter)

10.9Z8 Seminar in Topology (up to 4 q.h. per quarter)

10.9Z9 Seminar in Combinatorics (up to 4 q.h. per quarter)
The department offers an assortment of courses under the general heading "Seminar" (10.9Z6–9). At the outset of each quarter, times for organizational meetings will be posted. Schedule and content are negotiated at these meetings. Students and faculty with interest in the specialty of the *Seminar* are encouraged to attend the organizational meeting.

physics

Professors

Ronald Aaron, Ph.D., University of Pennsylvania
Petros N. Argyres, Ph.D., University of California (Berkeley)
Richard L. Arnowitt, Ph.D., Harvard University
Terence D. Clark, Ph.D., University of London
Alan H. Cromer, Ph.D., Cornell University
William L. Faissler, Ph.D., Harvard University
Marvin H. Friedman, Ph.D., University of Illinois (Urbana)
David A. Garelick, Ph.D., Massachusetts Institute of Technology
Marvin W. Gettner, Ph.D., University of Pennsylvania
Michael J. Glaubman, Ph.D., University of Illinois (Urbana)
Hyman Goldberg, Ph.D., Massachusetts Institute of Technology
Walter Hauser, Ph.D., Massachusetts Institute of Technology
Giovanni Lanza, Ph.D., University of Trieste
Robert P. Lowndes, Ph.D., University of London
Bertram J. Malenka, Ph.D., Harvard University
Pran Nath, Ph.D., Stanford University
Clive H. Perry, Ph.D., University of London
Eugene J. Saletan, Ph.D., Princeton University
Carl A. Shiffman, Ph.D., Oxford University
Jeffrey B. Sokoloff, Ph.D., Massachusetts Institute of Technology
Yogendra N. Srivastava, Ph.D., Indiana University
Michael T. Vaughn, Ph.D., Purdue University
Eberhard von Goeler, Ph.D., University of Illinois (Urbana)
Roy Weinstein, Ph.D., Massachusetts Institute of Technology
Allan Widom, Ph.D., Cornell University
Fa Yueh Wu, Ph.D., Washington University

Associate Professors

Arun Bansil, Ph.D., Harvard University
Robert S. Markiewicz, Ph.D., University of California

Assistant Professors

Laszlo Baksay, Ph.D., Rhenish-Westphalian Technical University (Aachen)
William Celmaster, Ph.D., Harvard University
John Chalupa, Ph.D., University of Washington
Ned S. Dixon, Ph.D., Stanford University
Linda S. Fritz, Ph.D., Stanford University
Christopher Jargocki, Ph.D., University of California (Irvine)
Jorge V. Jose, D.Sc., National University of Mexico
Marie Machacek, Ph.D., University of Iowa
Stephen W. McKnight, Ph.D., University of Maryland
Mark Novotny, Ph.D., Stanford University
Rajendra Prasad, Ph.D., University of Roorkee, India
W. David Shambroom, Ph.D., Harvard University

Research Associates

Henry Band, Ph.D., Duke University
Ali Chamseddine, Ph.D., University of London (Imperial College)
Frederic Green, Ph.D., Yale University
Sahadat Hossain, Ph.D., Tufts University
Olivia Meyer, Ph.D., University of Wuppertal
Jorge H. Moromisato, Ph.D., Northeastern University
Rajnikan S. Rao, Ph.D., Indian Institute of Technology (Bombay)

Procedure for Admission

All requests for information and application forms should be sent to the Graduate Director of the Physics Department. Completed applications and related materials, such as transcripts, letters of recommendation, and TOEFL scores (where applicable) should also be sent to the Graduate Director. GRE scores should be sent to the Graduate School of Arts and Sciences Office.

In addition to meeting the general requirements of the Graduate School of Arts and Sciences, applicants for admission to the graduate programs must have had an undergraduate program including the equivalent of at least twelve semester hours of upperclass physics beyond general physics and courses in calculus and ordinary differential equations.

To qualify as a regular student, the applicant should have completed upperclass courses in mechanics, electricity and magnetism, thermodynamics, modern physics, and quantum mechanics, as well as mathematical methods courses covering advanced calculus, linear vector spaces, and functions of a complex variable. Students whose background in one or more of these areas is weak may be required to satisfy prerequisites to the graduate courses by completing up to nine quarter hours of introductory courses listed in this catalog.

Students with undergraduate majors in fields other than physics may be admitted as provisional students, with entry to the regular program conditional upon the satisfactory completion of an appropriate group of undergraduate courses. Except for introductory courses listed in this catalog, these courses do not carry regular graduate credit.

The applicant is encouraged to take the Graduate Record Examination (both the aptitude section and the advanced physics section); scores should be sent to the Graduate School of Arts and Sciences Office.

International students are required to present evidence of sufficient competence in the English language to pursue the graduate program. For students whose previous instruction has been in a language other than English, this is normally done by submitting to the Physics Department results of the Test of English as a Foreign Language (TOEFL) examination, or other evidence in accordance with the Graduate School regulations.

Assistantships

A number of assistantships are available for full-time graduate students.

Teaching Assistantships. These awards offer a stipend plus a remission of

tuition for a regular graduate course load in exchange for half-time work in teaching in the undergraduate laboratories or equivalent work.

Tuition Assistantships. These awards provide remission of tuition for a regular graduate course load in exchange for approximately eight hours of work per week of grading assignments or similar work. Holders of these are eligible to become teaching assistants if such positions become available.

Research Assistantships. These awards, normally given to advanced students, provide the same benefits as teaching assistantships in exchange for work (usually related to the student's thesis research) on one of the research projects in the Department.

The Programs

The graduate programs in physics lead to the degrees of Master of Science (M.S.) and Doctor of Philosophy (Ph.D.). The M.S. program can be pursued on either a full-time or a part-time basis, but the Ph.D. programs require a full-time commitment.

Each student admitted to the graduate program must be interviewed by a departmental adviser, before registration for the first quarter at Northeastern, in order to assess the student's background and arrange for a suitable program of study.

THE MASTER OF SCIENCE DEGREE

Course Requirements

Forty-two quarter hours (q.h.) of graduate credit are required, of which up to twelve q.h. may be transfer credit on departmental approval (subject to general regulations of the Graduate School).

The following courses (with a total of thirty q.h. of graduate credit) are specifically required:

11.81A, 11.81B	Mathematical Methods A, B
11.82A	Classical Mechanics
11.834, 11.835	Electromagnetic Theory A, B
11.841, 11.842, 11.843	Quantum Theory A, B, C

The remaining twelve q.h. may be chosen from any courses carrying graduate credit in physics (or in related fields in science or engineering with the consent of the student's adviser). Not more than nine q.h. of credit in the introductory courses listed below may be used.

Sample Course Program for Part-Time Students

Year	Fall	Winter	Spring
I	Elective	11.240 Quantum Mechanics I	11.241 Quantum Mechanics II
II	11.81A Math Methods A	11.81B Math Methods B	11.82A Classical Mechanics
III	11.834 Electromagnetic Theory A	11.835 Electromagnetic Theory B	Elective*
IV	11.841 Quantum Theory A	11.842 Quantum Theory B	11.843 Quantum Theory C

*Students intending to enter the Ph.D. program should take 11.836 (Electromagnetic Theory C) in this quarter.

A part-time student can expect to complete the requirements for the M.S. degree in four years at the rate of one three- or four-quarter hour course per quarter, or sooner, by taking extra courses in some years or by taking courses in the summer quarter.

THE DOCTOR OF PHILOSOPHY DEGREE

The program for the Ph.D. degree consists of required course work, a qualifying examination, the completion of a dissertation based upon original research performed by the student, and a final oral examination.

Course Requirements

The following courses are required in addition to the required courses for the M.S. degree:

11.827, 11.828, 11.829	Statistical Physics A, B, C
11.836	Electromagnetic Theory C
11.848	Advanced Quantum Theory
11.86A, 11.86B, 11.86C	Particle and Nuclear Physics A, B, C
11.87A, 11.87B	Solid State Physics A, B

Sample Course Program for Full-Time Students*

Year	Fall	Winter	Spring
I	11.81A Math Methods A	11.81B Math Methods B	11.82A Classical Mechanics
	11.834 Electromagnetic Theory A	11.835 Electromagnetic Theory B	11.836 Electromagnetic Theory C
	11.841 Quantum Theory A	11.842 Quantum Theory B	11.843 Quantum Theory C
II	11.827 Statistical Physics A	11.828 Statistical Physics B	11.829 Statistical Physics C
	11.848 Advanced Quantum	11.87A Solid State Physics A	11.87B Solid State Physics B
	11.86A Particle and Nuclear A	11.86B Particle and Nuclear B	11.86C Particle and Nuclear C
III+	Qualifying Exam/Thesis Research		

*A student who is required to take one or more introductory courses to satisfy prerequisites will normally need three years to complete the required courses for the Ph.D. Individual programs must be worked out in consultation with a departmental advisor.

Qualifying Examination

The Ph.D. qualifying examination consists of a written part and an oral part, if required. It is normally given twice a year, once in September and once in January. The written part covers the material in the courses required for the Ph.D. and must be taken no later than the September following the completion of these courses. If the examination is failed, it may be repeated once only on the next occasion it is given.

Eligibility for the qualifying examination is determined by a departmental committee on the basis of the student's overall performance in course work. Full-time students are notified of their status sometime in their second year of study.

Part-time students who wish to become Ph.D. candidates may so indicate by

a petition to the graduate committee of the Department, which includes a timetable for completing the required courses and taking the qualifying examination.

Advanced Standing

A student may be admitted into the Ph.D. program with advanced standing based upon graduate courses taken elsewhere with transfer credit on departmental approval (subject to the general regulations of the Graduate School). However, the Ph.D. qualifying examination must be taken at Northeastern and the residence requirement satisfied.

Residence Requirement

A student who has completed the required course work and passed the qualifying examination becomes a doctoral degree candidate and must satisfy the residence requirement by one year of full-time graduate work.

Teaching Requirement

Some teaching experience is required. This requirement may be satisfied by at least one year of service as a teaching assistant or by suitable teaching duties.

Work-Study Option

A Ph.D. candidate may spend one year in a participating industrial or government laboratory immediately after passing the Ph.D. qualifying examination. In this program, the student is expected to remain in touch with the University by taking one course per quarter at the University and by frequent contact with a faculty adviser. After the one-year internship, the student returns to the University to do the dissertation.

Eligibility for this program is contingent on acceptance both by the department and by the external laboratory involved.

Dissertation

The student should arrange for a dissertation adviser prior to taking the qualifying examination.

The student may choose a field of research according to one of the following options:

a) In one of the research areas in the Department, under direct supervision of the adviser.
b) In an interdisciplinary research field involving another research area of the University, under the direct supervision of a researcher in that field. In this case an interdisciplinary committee is formed consisting of the direct supervisor, the departmental adviser, and one other member of the Department.
c) In an area of applied research in one of the industrial or high-technology

laboratories associated with the Department's Industrial Ph.D. Program. The direct supervisor is associated with the institution where the research is performed. In this case, a dissertation advisory committee is established consisting of the direct supervisor, the Departmental adviser and one other member of the Department.

An outline of the dissertation must be approved by the Department at least eight months before the final oral examination.

Final Oral Examination

The final oral examination is held in accordance with the Graduate School regulations.

AREAS OF ADVANCED STUDY AND RESEARCH

Theoretical Elementary Particle Physics

Research interests cover a range of topics including unified gauge theories of weak, electromagnetic, and strong interactions; grand unification and the early universe; supersymmetry; supergravity; phase transitions and spontaneous symmetry breaking; quantum field theory; quantum chromodynamics; lattice gauge theories; phenomenology of high-energy processes; quark models; relativistic multiparticle systems.

Experimental High-Energy Physics

An experimental group from Northeastern is collecting and analyzing data from the magnetic calorimeter (MAC) which is used to detect particles from the electron-positron colliding beam facility (PEP) at Stanford. The first results from this detector are just now being reported and much more remains to be done.

A large effort is being devoted to building a large multi-particle spectrometer including a liquid argon calorimeter to be used in one of the first experiments to be run at the Tevatron now being built at the Fermi National Accelerator Laboratory. This detector, with its excellent photon detecting ability, will be used to carry out several experimental tests of quantum chromodynamics.

Theoretical Solid-State Physics

Research interests of this group include statistical mechanics; theory of phase transitions; low temperature physics; theory of Josephson junctions; quantum circuits; quantum optics; Fermi liquid theory; localization and percolation in disordered systems; soliton and chaotic solutions of nonlinear systems; charge density waves; magnetism; electromagnetic and elastic properties of solids; optical properties of metals; transport theory.

Experimental Solid-State Physics

Researchers in this area use a broad range of in-house experimental tech-

niques such as Mössbauer spectroscopy, far infrared and laser Raman spectroscopy, high pressures, and low-temperatures including superconducting quantum interference devices (SQUIDS). Researchers are also involved off-campus in high magnetic field studies at the National Magnet Laboratory, and in neutron spectroscopy studies at the Brookhaven and Oak Ridge National Laboratories.

Current research topics include: infrared and optical studies of semiconductors, metals and metallic glasses as a function of temperature and pressure; transport phenomena in metals and semiconductors in low to very high magnetic fields; pressure dependence of electron-phonon scattering rates; X-ray, optical and fermi surface studies of intercalated graphites; two-dimensional physics and localization in ultrathin metallic films; magneto-optical studies of two-dimensional electron superlattices and single interfaces; neutron scattering of two-dimension magnetic systems and in weakly itinerant ferromagnets; infrared Raman, and neutron scattering of fast ion conductors; intermolecular interactions in fluids at high densities; superconductivity, in particular quantum phenomena in very high-frequency SQUIDS; very low temperature Mössbauer spectroscopy of the hyperfine interaction in mixed valence systems.

Research Facilities and Equipment

The main facilities of the department are located in the Dana Research Center, a modern building with ample library facilities, research laboratories, a central machine shop, an electronics shop, conference rooms, and offices for faculty and graduate students.

The Northeastern University Computation Center has three VAX 11/780 computers made by the Digital Equipment Corporation. The Physics Department has several terminals in the Dana Center for time-sharing access both to the VAX system and to outside networks as required for special projects. A research cluster with full input-output capabilities, including graphics display terminals, is planned for the near future.

DESCRIPTION OF COURSES

I. INTRODUCTORY COURSES

11.220 Thermodynamics and Kinetic Theory (3 q.h.)
Topics include first and second laws of thermodynamics; entropy and equilibrium; thermodynamic potentials; elementary kinetic theory; statistical mechanics and the statistical interpretation of entropy.

11.240 Quantum Mechanics I (3 q.h.)
The first of a two-quarter sequence in quantum mechanics, this course focuses on observations of macroscopic and microscopic bodies; the uncertainty principle; wave-particle duality; probability amplitudes; Schrodinger wave theory; one-dimensional problems. *Prep. 11.230 or equiv.*

11.241 Quantum Mechanics II (3 q.h.)
A continuation of 11.240, this course covers discrete and continuous states; Schrodinger

equation in three dimensions; angular momentum; general theory of quantum mechanics; applications. *Prep. 11.240.*

11.282 Introduction to Solid State Physics (3 q.h.)
This course offers a semi-classical treatment of the thermal, magnetic, and electrical properties of crystalline solids. Topics include X-ray diffraction and the reciprocal lattice; elasticity and lattice vibrations; specific heat; properties of insulators; magnetism in insulators and metals; introduction to the band theory of metals. *Prep. 11.220 and 11.230 or equiv.*

11.285 Introduction to Nuclear Physics (3 q.h.)
Topics include nuclear structure; nuclear masses; radioactivity; nuclear radiation; interaction of radiation and matter; detectors; fission, nuclear forces; elementary particles. *Prep. 11.230 or equiv.*

11.846, 11.847 Electronics for Scientists I, II (4 q.h.)
11.846 and 11.847 form a two-quarter sequence covering electronic techniques for experimental research in many different fields of science. Topics include principles of semiconductor devices; analog techniques (amplification, feedback, integration); digital techniques (counting, multiplexing, logic); design of electronic subsystems (analog-to-digital converters, phase-sensitive detectors, data-logging systems); understanding specifications of commercial electronic equipment. Lab examples make use of up-to-date integrated and discrete devices, such as are currently used in the electronic industry.

11.871 Radiation Physics (2 q.h.)
Introduction to atomic and nuclear physics for graduate students in biology and pharmacy. Topics include quantum mechanics and atomic structure, nuclear structure, radioactivity, properties of nuclear radiation, detection of radiation.

11.872 Radiation Biology and Health Physics (2 q.h.)
The effects of radiation on biological systems and the uses of radiation in medicine and biological research. Topics selected from effects of radiation on chemical reactions; effects of radiation on cells, organs, and individuals; theories of radiation damage and repair; imaging and tracer techniques using radiopharmaceuticals; radiation safety and standards. *Prep. 11.871 or equiv.*

II. REQUIRED REGULAR COURSES (Offered every year)

11.81A, 11.81B Mathematical Methods A, B (4 q.h.)
Calculus of variations. Euler Lagrange equations. Mathematical methods in physics. Topics from theory of function of a complex variable. Analytic functions. Taylor and Laurent series. Analytic continuation and classification of functions. Calculus of residues. Asymptotic series. Dispersion relations. Applications to ordinary differential equations and the study of special functions. Finite and infinite dimensional vector spaces. Linear operators. Function spaces and generalized Fourier expansions. Green's functions and integral equations. Introduction to group theory.

11.82A Classical Mechanics (4 q.h.)
Generalized coordinates and Lagrangian formulation of mechanics, conservation laws. One-dimensional and central force problems. Collision theory. Rigid bodies. Hamiltonian formulation and the canonical formalism. Continuous sytems and classical fields.

11.827 Statistical Physics A (3 q.h.)
The phenomenological theory of thermodynamics. Fundamental relations and thermodynamic potentials. Extremal principles of thermodynamics. Applications to simple systems. Stability conditions. Phase transitions. Thermodynamics of electric and magnetic systems. Principles of irreversible thermodynamics. *Prep. 11.82A and 11.841 (concurrently).*

11.828, 11.829 Statistical Physics B, C (3 q.h.)
The principles of statistical mechanics and statistical thermodynamics. Density matrix. Theory of ensembles. Derivation of the laws of thermodynamics. Fermi-Dirac and Bose-Einstein statistics. Application to gases, liquids, and solids. Theory of phase transitions. Second-quantization formalism for interacting systems. Cooperative phenomena. *Prep. 11.827, 11.841.*

11.834, 11.835, 11.836 Electromagnetic Theory A, B, C (3 q.h.)
Maxwell's equations. Static field and boundary value problems; multipole expansion. Phenomenology of dielectrics, conductors, and magnetic materials. Faraday's Law. Energy and momentum; Poynting vector; Maxwell stress tensor. Plane waves; polarization. Reflection and refraction; diffraction. Relativity. Radiation from sources. Applied topics from: Motion of charged particles in electromagnetic fields; magnetic mirrors, particle accelerators. Introduction to plasma physics; magnetohydrodynamics. Radiation from accelerated charges; bremsstrahlung, synchrotron radiation. Scattering of radiation; interaction of radiation with matter. *Prep. 11.212, 11.81A (concurrently).*

11.841, 11.842, 11.843 Quantum Theory A, B, C (4 q.h.)
Experimental basis of quantum theory. Schrodinger equation and probability interpretation of wave mechanics. Uncertainty principle. Application to one-dimensional problems, the harmonic oscillator, orbital angular momentum, and the central force problem. Quantum theory of scattering. Born approximation. Phase-shift analysis, introduction to S-matrix theory. General formulation of quantum mechanics in Hilbert space. Spin. Identical particles and symmetrization principle. Time-independent and time-dependent perturbation theory. Semi-classical theory of radiation and atomic spectra. Addition of angular momentum. Wigner-Eckart theorem. Quantum theory of radiation. Absorption, emission, and scattering of photons. *Prep. 11.240 or equiv.*

11.848 Advanced Quantum Theory (4 q.h.)
Introduction to the formulation of a relativistic quantum theory. Study of the Dirac equation and its Lorentz covariance. Plane-wave solution of the Dirac equation, and projection operators. Bound-state solutions of the Dirac equation in a Coulomb field and the hydrogen atom. Parity, charge conjugation, and time-reversal symmetries. Propagator theory. *Prep. 11.843.*

11.86A, 11.86B, 11.86C Particle and Nuclear Physics A, B, C (3 q.h.)
An introduction to nuclear and elementary particle physics. Topics are chosen from nuclear forces, nuclear models (shell model, collective model, unified model), nuclear scattering and reactions; classification of elementary particle interactions, Lorentz invariance, SU(3) and other internal symmetries, field theory, quark-parton model, deep inelastic scattering phenomena, unification of weak and electromagnetic interactions; unified gauge theories.

11.87A, 11.87B Solid State Physics (4 q.h.)
The course covers topics from Drude and Sommerfield (or free electron) models of electrons in metals, crystal structure, one-electron states in crystal lattices, Bloch's Theorem, semiconductors and semi-conducting devices, effects of electron-electron interactions, lattice vibrations and the classical and quantum theories of specific heat, optical properties of solids, investigation of crystal structure and excited states of crystals by X-ray and neutron scattering, simple transport theory based on the Boltzmann equation, magnetic properties of solids.

III. ADVANCED ELECTIVES

11.804, 11.805, 11.806 Advanced Solid State Physics A, B, C (4 q.h.)
Selected advanced topics in the theory of solids to be chosen each time by the interested students and instructor. For example, theory of normal metals, Hartree-Fock and Random phase approximations, optical and transport properties, solid-state plasmas, Raman spectroscopy, quasiparticles and collective excitations, quantum solids, amorphous solids. *Prep. 11.829, 11.843, 11.87B.*

11.817 Foundations of General Relativity (4 q.h.)
The course discusses the physical basis underlying relativity (the weak and strong principle of equivalence), the role of the metric tensor as a carrier of gravitational information, and the modification of the Lorentz covariant field equations in the presence of gravitation. An introduction to Riemannian geometry is given, and the Einstein field equations and tests of Einstein's theory are discussed. *Prep. 11.81B, 11.82A, 11.836, and 11.843.*

11.818 Relativistic Astrophysics and Cosmology (4 q.h.)
The course deals with the equations for the relativistic stellar system, white dwarfs, neutron stars and properties of pulsars, gravitational collapse and black holes, quantum radiation from black holes, super heavy stars as possible quasar energy sources, quantum effect in gravitational collapse, the metric for cosmological systems, and the big bang theory. *Prep 11.817 and 11.848*

11.819 Quantum Gravity (4 q.h.)
The course deals with gravitation as a quantum field, threshold properties of gravitational quantum S-matrix, quantization leading to a set of Feynman rules, calculations of simple tree diagrams, closed loop infinities and the problem of renormalizability of quantum gravity. *Prep. 11.818*

11.854, 11.855, 11.856 Fields, Particles, and Currents A, B, C (4 q.h.)
Introduction to a local field theory. Symmetries of the Lagrangian and conservation laws. Lorentz group, spin and helicity. P, C, and T. Klein-Gordon, Dirac, vector meson, photon and non-Abelian gauge fields. Gauge theories; Feynman path integral formulation. The S-matrix and LSZ reduction formulae. Spectral representations. Feynman diagrams. Green's functions at large Euclidean momenta. Renormalization and finiteness. Quantum chromodynamics. The renomalization group and asymptotic freedom. Spontaneous breaking and Higgs phenomenon. Glashow-Salam-Weinberg unified theory of weak and electromagnetic interactions. *Prep. 11.848*

11.857, 11.858, 11.859 Many-Body theory A, B, C (4 q.h.)
Introduction to some many-body problems and the required mathematical techniques. Theory of linear response and correlation functions. Landau's theory of Fermi liquids and

applications to solids. Theory of superconductivity and superfluidity. General theory of Green's functions and diagrammatic techniques. *Prep. 11.829, 11.843, 11.87B.*

11.91A, B, C (1 q.h.)
11.92A, B, C (2 q.h.)
11.93A, B, C (3 q.h.)
11.94A, B, C (4 q.h.)
Reading course, or theoretical or experimental work under individual faculty supervision. *Prep. Consent of faculty member.*

11.995 Doctoral Dissertation
Experimental and theoretical work for Ph.D. candidates.

political science

Professors

Robert E. Gilbert, Ph.D., University of Massachusetts, Chairperson
Robert L. Cord, Ph.D., Syracuse University
David E. Schmitt, Edward W. Brooke Professor, Ph.D., University of Texas

Associate Professors

L. Gerald Bursey, Ph.D., Harvard University
Minton F. Goldman, Ph.D., Fletcher School of Law and Diplomacy
Suzanne Ogden, Ph.D., Brown University
Steven Worth, Ph.D., University of Washington

Assistant Professors

Stephen F. Coleman, Ph.D., Boston University
Malcolm L. Cross, Ph.D., University of Missouri
Bruce M. Logan, Ph.D., University of Chicago
Eileen L. McDonagh, Ph.D., Harvard University
Donald J. Reaves, Ph.D., Kent State University
Stewart Reiser, Ph.D., Harvard University

Instructors

David A. Rochefort, Ph.D. Candidate, Brown University
Frank Schepps, Ph.D. Candidate, State University of New York, Binghamton

Part-Time Faculty

Rev. Edward F. Boyle, M.B.A., Amos Tuck School of Business Administration
Holly M. Carter, Ph.D., Massachusetts Institute of Technology
Ernest W. Cook, Ph.D., Ohio State University
Oleta L. Crain, M.P.A., Northeastern University
Maxim Dem'Chak, M.P.A., Northeastern University
Richard M. Gladstone, M.C.P., University of Cincinnati
Robin Goldsmith, J.D., Suffolk University
Robert A. Hankin, Ph.D., Northeastern University
Victoria Hayward, J.D., University of San Diego
Katherine A. Hesse, J.D., Boston University
Alvin L. Jacobson, Ph.D., Cornell University
Nancy K. Kaufman, M.S.P., Boston College
Paul Keough, M.P.A., Northeastern University
Ruth Kenworthy, M.P.A., Northeastern University
Ronald E. Lawson, D.B.A., Boston University
Othello Mahone, M.P.A., Harvard University
Robert H. McClain, Jr., M.S., University of Denver
Walter W. Mode, M.P.A., University of Minnesota
Richard B. Morrison, Ed.D., Boston University
Robert J. M. O'Hare, M.S., Boston University
J. Richard Poulin, M.P.A., University of Oklahoma
Carl A. Prussing, M.P.A., University of New Hampshire
Grant Rhode, Ph.D., Fletcher School of Law and Diplomacy
Marvin Siflinger, M.P.A., Syracuse University

Michael L. Simmons, M.P.A., Northeastern University
Wallace E. Stickney, M.S., Northeastern University
Marilyn Swartz-Lloyd, M.C.P., Yale University
John Warren, M.B.A., Boston College

Admission

In addition to the admission requirements listed on page 19, applicants for the Master of Arts program should have a background which includes at least six semester hours of political science, government, or related courses. Test of English as a Second Language (TOEFL) scores are required for international applicants.

Applicants for the Master of Public Administration program should demonstrate a clear and strong interest in public administration. All applicants for admission must furnish a statement supporting their interest in this field and outlining their reasons for wishing to enter the program. Although most candidates for the program come with a major concentration in the social sciences, such a background is not mandatory, and applicants from other fields such as engineering, law, sciences, or business administration are considered for candidacy.

All applicants to Political Science M.A. graduate programs, including persons seeking special, nondegree status, must follow regular admissions procedures.

THE MASTER OF ARTS DEGREE

Program

Forty quarter hours of academic work are required. With the approval of the faculty adviser, a maximum of nine quarter hours may be selected from graduate courses in other departments and a maximum of eight quarter hours may be selected from advanced undergraduate courses.

A thesis is optional with the approval of the chairperson of the Department. If approved, a thesis carries six quarter hours of credit.

Comprehensive Examination

The comprehensive examination is held in accordance with the general Graduate School regulations. Every candidate for the degree must pass examinations in two fields as prescribed by the Department. Degree candidates are limited to two attempts at successful examinations in each field. Choice may be made from the following fields: American Government, Comparative Government, International Relations, Political Theory, and Public Administration.

THE MASTER OF PUBLIC ADMINISTRATION DEGREE

Program

Forty-two quarter hours of academic work are required. All students must complete the following eight courses:

22.871 Public Finance and Budgeting
22.880 Survey of Public Administration
22.882 Public Personnel Administration
22.892 Techniques of Policy Analysis
22.928 Organization Theory and Management
22.970 Quantitative Techniques for Public Administrators I
22.971 Quantitative Techniques for Public Administrators II
22.980 Quantitative Techniques III: Computer Applications

At least five additional courses must be selected from courses designated public administration electives. Not more than four courses may be selected from other graduate courses offered by the Department or the University, and these must have the approval of the faculty adviser except for those offered by the Department of Political Science.

All students beginning the M.P.A. program who have not had an introductory American government course at the undergraduate level are required to take 22.800 Seminar in American Government. Students entering the program who have not completed an undergraduate-level course in economics are required to take 39.9F6 Economics for Public Administrators.

M.P.A. Concentrations

Students may elect to declare an M.P.A. concentration after completing core courses. Concentration areas include: (1) Public Organization and Management, (2) Public Finance and Budgeting, (3) Public Personnel Administration, (4) State and Urban Government, and (5) Policy Sciences. The concentrations seek to provide integrated course offerings in key public administration fields. Each concentration area is coordinated by a full-time faculty member, who also serves as adviser to students in his or her area of concentration. There are four required courses in each concentration as well as a variety of electives which may be selected on the basis of professional or academic interests.

Off-Campus Facility

With the cooperation of the Federal Executive Board, the Department of Political Science offers its Master of Public Administration Program at the John F. Kennedy Building in downtown Boston. This program is primarily for individuals employed in federal, state, or local civil services and normally courses are given in the evening.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified. Most courses are seminars.

22.800 American Government
Analysis in depth of selected problems in American government. Examples of problems include transition of American political parties, legislative reapportionments, and the decline of Congress as a law-making body. *M.P.A. elective.*

22.805 Scope and Methods of Political Science
This course is designed as an in-depth examination of the assumptions, principles, etc. that underlie contemporary political science. As such, it invites the student to consider the present practice of the discipline in the light of its history and to critically evaluate the discipline in the interest of a greater understanding of nature and limits.

22.810 Models of Political Systems
A detailed examination and critique of current models of political systems.

22.812 Political Psychology and Socialization
An examination of theories of political psychology, opinion formation, and attitude change; of political ideology; of processes of individual political development and socialization; of effects on mass and elite political behavior; of attitudinal differences and differential socialization experiences; of individual political behavior and the political system.

22.813 Eurocommunism
A study of the ideology and political behavior of the communist parties of Italy, France, and Spain, with emphasis on their independence of, and challenges to, the domestic and foreign policies of the Soviet Communist Party.

22.814 International Organization
This course focuses on issues of international political economy. The role of various international organizations in managing economic interdependence is emphasized. Attention is given also to the role of international administrators in the UN's search for a new International Economic Order. Discussion of nongovernmental organizations, such as multinational corporations, is included.

22.815 Politics and the Mass Media
Study of the role of mass media in the formation of public opinion, with special attention given to media usage in the electoral process.

22.820 Legislative Process
Study of Congress and of the influence of the President, administrative bureaucracy, parties, interest groups, and public opinion on the development of legislative policy. Comparisons are made with legislative process in the states. *M.P.A. elective.*

22.821 Theories of American Political Participation
This course focuses on political behavior at both the national electorate level and at the level of legislative roll-call voting, analyzing the relative impact of demographic and attitudinal components as well as the effect of constituency and partisan identification upon legislative behavior.

22.822 American Constitutional Law
Employing excerpts of U.S. Supreme Court decisions and other primary legal materials, this course examines the constitutional rationale for judicial review; various philosophical approaches to the exercise of judicial power; and the scope of judicial authority to settle questions challenging the legitimacy of governmental actions in the American constitutional system.

22.823 American Constitutional Law II
Using excerpts of primary legal materials, this course builds upon the judicial doctrines

developed in 22.822 and specifically examines the constitutional theories behind the growth of congressional prerogatives in economic and social affairs, and expanding presidential power in internal and foreign matters. *Prep. 22.822 or consent of the instructor.*

22.824 The Presidency
An analytic treatment of the constitutional and extraconstitutional powers of the contemporary president; an examination of the place and function of the chief executive in the formulation and execution of public policy. *M.P.A. elective.*

22.826 American Electoral Behavior
The theoretical and methodological assumptions of election studies of the American political system are analyzed and the substantive conclusions carefully reviewed.

22.828 The Judiciary
Analysis of the role of the judiciary in the American governmental process. Special attention is given to those areas of constitutional law in which the Court's decisions have a profound impact on the basic structure of American politics (apportionment, economic regulation, federalism, etc.).

22.829 Political Parties, Pressure Groups, and Public Policy
A study of the role of parties and pressure groups in the policy-making process; trends in contemporary party politics are examined as well as behavior patterns of the American electorate.

22.830 Civil Rights
Examination of the doctrine of constitutionalism, illustrated and amplified by a study of the substance and process of the Bill of Rights as developed in decisions of Federal courts, and Congressional enactments.

22.831 Procedural Due Process
Utilizing excerpts from U.S. Supreme Court decisions and other legal materials, this course examines the philosophical and constitutional relationships between Amendments 4, 5, 6, and 8 and the Fourteenth Amendment. The substance of the right to fair trial, counsel, confrontation, protection against self-incrimination, and unreasonable searches and seizures are among the many procedural rights examined through the decisions of the Roosevelt, Vinson, Warren, and Burger Courts.

22.832 Intergovernmental Relations
An institutional-behavioral analysis of the changing relationship between the various levels of American government—national, state, and local—relating the pattern of change to the social and economic forces which underlie it. *M.P.A. elective.*

22.834 Constitutional Law in Public Administration
An introduction to American constitutional law and the federal system using case materials and emphasizing principles of importance to public administrators, including such constitutional concepts as separation of powers, judicial review, dual federalism, legislative investigating power, executive impoundment, federal preemption, and the appointment and removal power. *M.P.A. elective.*

22.838 Administrative Ethics in Public Management
An analysis of ethical problems in American public administration including discussion of

ethical dilemmas frequently faced by public managers. *M.P.A. elective.*

22.840 State Government
Appraisal of the problems of contemporary state government in the U.S. Particular emphasis is given to the state government of Massachusetts. Individual research is stressed. *M.P.A. elective.*

22.841 Problems in Urban Planning
An exploration of the resources available to the urban planner for policy implementation, including zoning, subdivision regulation, and capital improvement programs. Special emphasis is given to the planning of individual sites. *M.P.A. elective.*

22.842 Techniques of Urban Planning
A study of the history and techniques of city planning, stressing the elements of planning. *M.P.A. elective.*

22.843 Politics of State and Urban Planning
An investigation of the relationships of planning to other governmental functions with stress on practical processes, particularly at the municipal government level. *M.P.A. elective.*

22.844 Urban Government
The contemporary crisis in urban government — problems of political independence, government finance and administration, rapid growth of suburban and metropolitan areas, and decline and decay of the core city are stressed. Particular emphasis is given to the Boston metropolitan area. Individual research is stressed. *M.P.A. elective.*

22.847 Transportation Policy
Examination of the role of politics, governmental mechanisms and public policy in the transportation planning process. Particular attention is given to political interest groups and the manner in which they affect transportation policy on the federal, state, and local levels. *M.P.A. elective.*

22.848 Problems of Community Development
Examination of the role of government, politics, and public policy in the urban process and related problems in the United States. *M.P.A. elective.*

22.850 Parliamentary Democracy in Western Europe
A comparative analysis of environment, vehicles of popular participation, and formal structures and reach of government in the parliamentary democracies of western Europe. Special attention is given to England, France and Germany.

22.851 Comparative Communism
A comparative analysis of environment, vehicles of popular participation, and formal structures and reach of government in the Soviet Union, the socialist countries of Eastern Europe, and China.

22.852 European Political Parties
A comparative cross-national study of political organization and behavior in England, France, and Germany with emphasis on party leadership, strategy, organization and constituency as well as socialization, recruitment, and participation of voters.

22.853 Crisis Politics in Democracies and Dictatorships
Analysis of governmental response to crises and emergencies. Consideration of such topics as war powers, riot and rebellions, martial law, transfer of regime, succession problems, economic crises, presidential emergency powers, national security powers, executive privilege, and impeachment.

22.854 Totalitarianism
An analysis of totalitarianism and dictatorship, including study of historical background; fundamental characteristics; theories of origin, nature, and significance; and evaluation of techniques, ideologies, policies, and instruments of power. Special attention is given to the government and politics of the Soviet Union.

22.855 Government and Politics in Germany
A study of political culture, federalism, and executive-legislative relations on the national level with a view to appraising the quality and durability of the present democratic system.

22.856 Government and Politics of France
A study of current governmental organization and political behavior in France. Special attention is given to the role of the presidency, executive-legislative relations, and the political party system.

22.857 European Legislative Systems
A comparative analysis of the legislatures in Britain, France, and Germany with emphasis on patterns of historical development, functions, internal organizations, and relations with the executive.

22.858 Government and Politics of the United Kingdom of Great Britain and Northern Ireland
An analysis of government organization and political behavior in the United Kingdom. Special attention is given to executive-legislative relations, the political party system, and the politics of Northern Ireland.

22.859 European National Executives
A comparative cross-national study of executive decision making in England, France, and Germany with emphasis on varying patterns of presidential and cabinet authority as well as relationships with the legislature.

22.860 Collective Bargaining in the Public Sector
Study of the mechanism for labor relations in federal, state, and local government with its impact on the public manager. Emphasis is placed upon collective bargaining processes, tactics, and techniques. *M.P.A. elective.*

22.861 Grantsmanship
This course provides students the opportunity to increase their knowledge of the federal grant system. Emphasis is placed on developing the ability to write effective grant proposals and on improving management skills of federal grants.

22.863 Management Information Systems
The course studies the life cycle of a management system through its three phases: (1) study and design; (2) implementation; and (3) operation within the target organization. Focus is on exploring the impact which management information systems have and may

have in the future on governmental managers, on their professional environment, and on the society which they serve. Various government MIS will be studied. The course requires no mathematical or data-processing background. *M.P.A. elective.*

22.865 Computers and Public Administration
A general orientation to the computer, its uses and operation, with particular attention to programming analysis, preparation and coding, and use of computer programs specifically written for governmental applications. *M.P.A. elective.*

22.868 Health-Care Administration
An examination of the politics and administration of health-services delivery systems, including a discussion of current topics in health-care administration and politics (e.g. national health insurance, health-maintenance organizations, physician assistants, citizen participation, administration decentralization) and an introduction to current developments in policy evaluation methodology and health-services research. *M.P.A. elective.*

22.869 Housing and Community Development
An introduction to exploration of two major urban social policy issues in terms of their political, economic, and social dimensions. Specific programs and issues in the metropolitan and New England region are evaluated. *M.P.A. elective.*

22.871 Public Finance and Budgeting
Emphasizes the public budgeting function in its relationship to other functions of public administration. The subject is approached from a management perspective, and conflicting legislative and executive finance and budgeting interests are examined. Also included is an illustration of the budget cycle and an examination of the mechanics of budget preparation. Attention is given to means for improving budget decision making and administration through quantitative and other methods. *M.P.A. core course.*

22.872 Public Fiscal Management
A study of the interrelationships in public administration between systems of finance and the achievement of program objectives. Emphasis is placed upon those aspects of the budgetary process that bear on fiscal policy and appropriations. *M.P.A. core course.*

22.874 Functions and Techniques of Public Management
An introduction to problems in public management and techniques for dealing with them, including functions of middle management, supervision, administration of staff activities (e.g. planning, personnel, budget), organization and methods, public relations, managerial use of computer-based techniques, and tactics and strategies of management. *M.P.A. elective.*

22.877 Environment and Energy Policy
Consideration of the legal, political, administrative, and intergovernmental factors involved in the formulation of public policy and the exercise of public power in regulating the use of the environment. Individual research is stressed. *M.P.A. elective.*

22.880 Survey of Public Administration
Introduction to the literature and the major topics in public administration with special attention given to the interrelationships of politics and administration. *M.P.A. core course.*

22.882 Public Personnel Administration
Technique, practice, and organization of personnel functions in public administration, including recruitment, compensation, training, discipline, and relations with employee organizations. *M.P.A. core course.*

22.883 Comparative Public Administration
A comparative study of approaches to public administration in selected democratic governments in the United States and Europe. *M.P.A. elective.*

22.888 Federal Administrative Law
Study of rule making, adjudication (formal and informal), administrative finality and judicial review, administrative procedure, scope of administrative powers, and enforcement techniques. *M.P.A. elective.*

22.889 Governmental Accounting
Examination of principles and procedures involved in governmental accounting. *M.P.A. elective.*

22.892 Techniques of Policy Analysis
Focuses on the various techniques useful in analyzing public policy issues. Case studies of specific applications of such methods as modeling, simulation, and survey research are examined. *M.P.A. elective.*

22.894 Techniques of Program Evaluation
A review of the various methods used to assess public policy including identification and categorization of outcome, input and program operation variables; types of research designs; and steps needed to institute program change after completion of an evaluation study. *M.P.A. elective.*

22.896 Management Planning for Public Organizations
A review of the growth of the planning approach to public management and of its application in specific agencies. Topics include organization of the management planning function, budget planning, and methods of providing planning forecasts. *M.P.A. elective.*

22.898 Organizational Psychology and Behavior
Examination of the literature, theories, and concepts of administrative behavior as it has evolved with emphasis on the development of self-awarenss and the building of interpersonal skills. *M.P.A. elective.*

22.899 Public Policy Issues in Human Services
Discussion of the origins and development of the Social Security Public Assistance Income Maintenance and various health-care programs. The course content focuses on controversial public policy issues of retirement, survivors, disability insurance, aid to families with dependent children, medicare, and medicaid, with the objective of helping students to develop understanding of the push and pull of many different viewpoints involved in public policy development. *M.P.A. elective.*

22.900 Ancient and Medieval Political Thought
The development of political thought from Greek antiquity to the end of the Middle Ages, utilizing both historical and analytical approaches. Attention is also paid to the cultural, social, and intel!ectual context within which political theories develop.

22.901 China in Revolution
Addresses the problems faced by a revolutionary China in forming new attitudes, instituting a revolutionary political culture, and reconstructing and developing a country on the basis of a revolutionary ideology. Illustration of the manner in which the party, state, military, education, health, science, and medicine have been modified since 1949 to ensure the continuation of a revolutionary polity.

22.902 Seminar in International Relations
An in-depth analysis of the major actors, their goals, and the means and strategies they utilize within the international system.

22.903 Soviet-Chinese Relations
A chronological and topical analysis of the Soviet-Chinese relationship since 1950 with special attention to the causes of rivalry and conflict in the 1960s and 1970s.

22.906 Position Management
An examination of the bases of position classification at the state, federal, and local levels. After reviewing the process of job analysis, the course examines several classification schemes including the new Federal factor benchmark system. Final topics include wage and salary administration. *M.P.A. elective.*

22.908 Manpower Policy and Administration
Introduces the student to human resource policy and management issues within a broader context of social policy. Includes an investigation of specific manpower programs and current issues of importance to the administrator. *M.P.A. elective.*

22.910 Modern Political Thought
Examination of political thought from Machiavelli to Marx.

22.912 Regulatory Administration
This seminar is designed to offer the public manager a conceptual and historical overview of the development of regulatory policy and mechanisms, focusing on issues at the public-private interface as well as evaluating the practical implications of government intervention. Also included is an evaluation of the political, economic, and administrative effects of a nonregulatory vs. regulatory approach to public management. *M.P.A. elective.*

22.913 Group Dynamics
Based upon an introductory understanding of organizational psychology and behavior, this seminar focuses on the human problems public managers face in their daily work. Using a group dynamics format, each participant will have the opportunity to integrate the literature in organizational psychology, work issues, and personal growth concerns. *M.P.A. elective.*

22.918 Civil Liberties in Public Administration
Discussion of First Amendment rights as they impact upon the public sector. Referring to appropriate court cases, topics include employee rights and obligations with respect to freedom of speech, freedom of association, loyalty oaths, and professional certification, as well as legislative powers. *M.P.A. elective.*

22.919 Political Economy of Public Administration
A central concern of this course is to introduce a construct of public economy as a means for focusing on contemporary issues facing public administrators. Both the concepts and applications of political-economic analysis are presented to offer the student a new analytical tool for evaluating public policy, implementation, and impacts on the citizenry. *M.P.A. elective.*

22.920 Contemporary Political Theory
The main currents of political thought in the latter half of the nineteenth and the twentieth centuries with special emphasis on the relations between political theory, philosophy, and political science.

22.921 Survey Research for Public Administration
Focuses on the entire survey research process from ample selection to data analysis. Regression for time series analysis and some computer applications are discussed. *Prereq. 22.970*

22.922 Computer Software for Public Administrators
This course will be offered as an elective at least once per year. The course will provide an introduction to several software packages for: statistics; management file construction and use, word processing, and graphics. *Prereq. 22.970.*

22.923 Politics and Administration in Cities and Towns
An examination of the political and administrative structures which influence the conduct of city and town governments. Particular attention is given to the dynamic relationships between these structures and the implications for public policy-making. *M.P.A. elective.*

22.924 Strategy in Politics
An examination of formal theories of political behavior, stressing elements of strategy and their implications. Relationshps between political factors, patterns in political processes, bargaining, decision making, and voting are covered.

22.926 Trends in American Political Thought
Examination of intellectual concepts and movements that have informed and influenced American political life, with emphasis upon those relating to the making and execution of public policy. *M.P.A. elective.*

22.928 Organization Theory and Management
An in-depth study of the major organization theories, including the scientific basis for organization theory; models and ideal types; decision making; application of game theory; systems analysis. *M.P.A. core course.*

22.929 Organizational Analysis
A study of the structure and processes of organization essential for problem solving and for effecting organizational change. Emphasis is placed upon the application of social science theory and administrative principles in administrative problem identification and problem resolution. *M.P.A. elective.*

22.932 State and Local Finance and Budgeting
This course explores the many channels that the state budget must travel before it be-

comes a viable document. The several ways by which the budget can be affected before and after it is signed into law are explored in depth. *M.P.A elective.*

22.938 Municipal Finance
A discussion of the special problems of budgeting and finance in local governments, including budget preparation and presentation, debt management, capital financing, and local taxation policy. *M.P.A. elective.*

22.939 Municipal Law
Designed for the nonlawyer, this course reviews the law of municipal corporations. Topics include general powers and duties, charters, ordinances, administrative rules and regulations, officers and employees, tort liability, policy powers, planning and zoning, taxation and borrowing, elections and licenses and permits. *M.P.A elective.*

22.940 Comparative Urban Government and Administration
This course analyzes decision-making structures and processes in selected urban areas, including an examination of world organization trends and implications for administration and politics of cities; changing scopes, scale, participants, and organization of urban politics; and selected issues such as urban housing, finance, leadership, planning and goals. *M.P.A. elective.*

22.942 Asia and the Politics of Development
This course relates the theoretical literature on political development to the concrete attempts to develop in Asia. Because of the diversity in levels and types of political development in Asian states, each student is encouraged to concentrate on one state and explore different ideas about political development as they relate to that state.

22.943 The Governments and Politics of Latin America
This course investigates contemporary Latin American politics with particular emphasis on revolution, development strategies, and social change. Focus is on three representative nations such as Mexico, Chile, and Cuba.

22.944 Nationalism
The evolution and role of nationalism in both theory and practice. Representative nationalistic movements and theories are analyzed.

22.945 Development Politics
The process of political development in the Third World, including both internal and international issues such as leadership patterns, the role of the military and political parties, and underlying economic and social factors.

22.946 The Politics of Revolution and Change
Analysis of the nature of political change with attention to both theory and practice. Topics discussed are revolution, major trends in contemporary politics, and the relationship between political change and technological, scientific, or social change.

22.948 Government and Politics of North Africa and the Middle East
Comparative analysis of the political systems and foreign policies of African states north of the Sahara. Also stressed is the relationship of this area with the Middle East.

22.949 The Great Powers and the Middle East
An analysis of the changing nature of great power and multinational involvement in the Middle East.

22.950 United States-Soviet Relations
The relations between the United States and the Soviet Union from 1917 to the present. Topics stressed are the "nonrecognition" period, the breakdown of the World War II "Grand Alliance," and the nature of the present power conflict.

22.951 United States-Far Eastern Relations
American diplomacy in the Far East, with primary concentration on relations with Japan since World War II, with China, and with Southeast Asia.

22.952 China's Foreign Policy
A study of the Chinese government's relations with the Third World socialist states and the West and its behavior in the United Nations. Analyzes changing policies toward international law, trade, tourism, scholarly exchange, and foreign ventures in China. Attention is given to policy objectives, strategy, tactics, and the method of decision making in the foreign policy apparatus.

22.954 Soviet Relations with Eastern Europe
An analysis of Soviet policy in Eastern Europe, especially Russian efforts after World War II to develop communism and maintain a position of preeminence in this region.

22.955 Chinese Politics
Concentrates on the objectives of the Chinese revolution from 1911 to the present. Examines the political theory and institutions which have been established to promote "permanent revolution" and evaluates the rationality of Chinese communist policies in terms of Chinese goals. Concentrates on the changes made in domestic, economic, legal, and political policies since 1976.

22.957 Japanese Politics
Designed for students in both comparative politics and in international relations, the course examines the unique Japanese electoral system, political processes and organizations, political culture and socialization, the role of business in politics, and Japanese foreign policy.

22.958 Decision Making in U.S. Foreign Policy
Comprehensive analysis of the governmental mechanism and process for decision making in U.S. foreign policy. Case studies in decision making are emphasized.

22.959 American Foreign Policy
Examination in depth of selected issues concerning the role of the United States in world affairs since 1945.

22.960 Problems of World Order I
Emphasizes such topics as appraisal of diverse systems of public order, approaches of international law and international organization to the problem of world order, and the problem of world peace enforcement.

22.961 Problems of World Order II
Political problems of world order are stressed. Representative topics include arms control and disarmament, the limits of economic growth, international political economy, population problems, and resource distribution.

22.962 Arab-Israeli Dispute
The Arab-Israeli confrontation has its own dynamics and a character that has changed through the decades. This course analyzes its interaction with the internal politics of the Arab states and Israel, Pan-Arab politics, and the role of the great powers in the region.

22.963 Soviet Foreign Policy
A study of Soviet foreign policy since 1964. Among the topics discussed are détente in relations with the United States; polycentrism in East Europe; involvements and commitments in the Middle East and Africa; and the dispute with China.

22.964 The United Nations
Selected topics on the nonpolitical work of the United Nations: human rights; economic, social, health and related problems; decolonization and the trusteeship system.

22.965 International Peace Keeping
A detailed investigation of the origins, history, and theory of interventionary peace keeping, with reference to the documentation of the United Nations. An assessment of this method of maintaining regional stability and a projection of potential means of developing the method to broader applicability.

22.966 International Law
Examination of selected topics in international law not covered in 22.960 and 22.961.

22.967 Regional Organization
Regional organizations, such as EEC or OAU, are studied to determine the capability of such organizations to promote economic development and political influence.

22.968 The Atlantic Community
A topical analysis of European-Amerian diplomacy with particular stress upon security and economic matters. Major consideration of the integration of Europe, American responses, and the results of these interactions for world political and economic stability.

22.969 Terrorism, Violence, and Politics
Analysis of the theory and practice of terror, violence, coercion, force, and threats in political life.

22.970 Quantitative Techniques for Public Administrators I
A consideration of the theory and process of administrative study including philosophy of science, quantitative and qualitative designs and methods of problem solving, and drawing causal principles. *M.P.A. core course.*

22.971 Quantitative Techniques for Public Administrators II
The application of social science research and computer programming to administrative problems, including techniques for analysis of survey and other data and practical methods of gathering, analyzing, and presenting such data. *M.P.A. core course.*

22.972 Techniques of Public Budgeting
Introduction to the practical skills necessary for the formulation, evaluation, and presentation of budget data. Budgetary information (raw data) provided from computer simulations and from state and local governments are analyzed and adapted to various types of budget formats. *M.P.A. elective.*

22.973 Politics and Issues in Public Budgeting
The study of public budgeting in the context of the political, financial, and economic environment of present-day government. A heavy focus on contemporary issues and events which affect budgetary processes in the public sector is included. *M.P.A. elective.*

22.974 Women in Public Management
Analysis of the multiple roots of problems experienced by women in public management positions and solutions for alleviating such problems. Students are expected to engage in experiential learning exercises in addition to academic work. *M.P.A. elective.*

22.975 Equal Opportunity in Public Administration
This course is designed to (1) examine barriers to EEO; (2) help students develop an awareness of issues surrounding the Affirmative Action Program and particularly some of the historical perspectives of discrimination against minorities and women; and (3) offer instruction in techniques for developing a meaningful equal opportunity program for public organizations. *M.P.A. elective.*

22.976 Legal Issues in Public Personnel Administration
A review and discussion of fact situations and evidence which give rise to public employment litigation with emphasis on civil rights and Equal Employment Opportunities court actions. Class discussion includes the type of evidence used in litigation and the types of defenses available to public employers. *M.P.A. elective.*

22.977 Labor Relations in Public Administration
Examination of various theoretical models for analyzing labor-relations structures and dynamics as well as their historical development in the United States. Where appropriate, attention is given to private sector patterns for comparative analysis. Among the topics treated are bargaining unit determinations, management rights and the scope of bargaining, coalition bargaining, impasse-procedure options, contract administration, affirmative action, civil-service traditions, and public sector unions. *M.P.A. elective.*

22.978 Public Relations in Public Administration
Focuses on evaluting the public manager's role in the process of communication with the public. Issues of imagery and accountability as well as current topics are evaluated. *M.P.A. elective.*

22.979 Social Welfare Policy and Administration
The historical, political, social, and economic determinants of the U.S. social welfare system are examined. Present policies and programs are analyzed using a dynamic systems model. Practical experience from all levels of government is included. *M.P.A. elective.*

22.980 Quantitative Techniques III: Computer Applications
A continuation of the study of quantitative techniques, with particular emphasis on various computer usages for public managers.

22.982 Career Development
Designed to help students make career choices, identify their own career stages, and better understand their role as part of a work organization, with the purpose of assisting students in career planning. *M.P.A. elective.*

22.983 Federal, State and Local Financial Relations
As state supervision of and assistance to local governments in the area of financial administration is becoming increasingly important, this course explores the relationships between the two levels of government in the assessment and collection of taxes, budgeting, debt management, and state aid. In addition, the federal role and fiscal intergovernmental relations are evaluated. *M.P.A. elective.*

22.988 Health Policy and Politics
An analysis of health care policies, procedures, and alternatives.

22.989 Practices in Self-Development in Public Management
This course focuses upon practical aspects of public management. Topics include time management, communication (e.g., memorandum and report writing), control processes, and conflict management.

22.990 Assigned Reading (maximum: 6 q.h.; minimum: 1 q.h.)
Assigned reading under supervision of a faculty member.

22.991 Thesis (6 q.h.)
Thesis supervision by individual members of the Department.

22.992 Internship Readings and Analysis
Academic credit directly related to an internship assignment.

22.993 Elder Services Policy and Administration
This course investigates the historical, socio-economic and philosophical determinants of the emerging elder services system. Present policies and programs are studied using various comparisons, case studies, and dynamic models. Focus on contemporary problems in the administration of elder care delivery systems, funding sources, and future trends.

22.994 Seminar in Public Organization and Management
Analysis of specified topics and issues in public organization and management, with the purpose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

22.995 Seminar in Public Finance and Budgeting
Analysis of specified topics and issues in public finance and budgeting with the purpose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

22.996 Seminar in Public Personnel Administration
Analysis of specified topics and issues in public personnel Administration with the pur-

pose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

22.997 Seminar in Policy Sciences
Analysis of specified topics and issues in the policy sciences with the purpose of presenting material of current interest and allowing in-depth research into specified areas. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

22.998 Seminar in State and Urban Administration
Analysis of specified topics and issues in state and urban administration with the purpose of presenting material of current interest and allowing in-depth research into specified areas where appropriate. Subject matter to be covered is described in registration materials. *M.P.A. elective.*

22.999 Topical Seminar
The program occasionally offers a special seminar dealing with current important issues relevant to public administration.

39.9F6 Economics for Public Administrators
Introduction to basic economic concepts essential to other courses in the program. This course is a prerequisite for students lacking economic course work at the baccalaureate level.

pyschology

Acting Chairperson
Martin Block, Ph.D., University of Pittsburgh

Professors
John C. Armington, Ph.D., Brown University
Harlan Lane, Ph.D., Doc. es Lettres, Harvard University
Helen Mahut, Ph.D., McGill University
Bertram Scharf, Ph.D., Harvard University
Murray Sidman, Ph.D., Columbia University
Alexander A. Skavenski, Ph D., University of Maryland
Michael Terman, Ph.D., Brown University
Harold S. Zamansky, Ph.D., Harvard University

Associate Professors
Edward A. Arees, Ph.D., University of Massachusetts
Roger F. Brightbill, Ph.D., Harvard University
Perrin S. Cohen, Ph.D., Columbia University
Francois Grosjean, Ph.D., University of Paris
Charles Karis, Ph.D., Boston University
Harry A. Mackay, Ph.D., Queen's University
Joanne L. Miller, Ph.D., University of Minnesota
Lawrence T. Stoddard, Ph.D., Columbia University

Adjunct Professor
Margaret Bauman, M.D., Medical College of Pennsylvania

Assistant Professors
Stephen Harkins, Ph.D., University of Missouri
Judy A. Shepard-Kegl, M.A., Brown University

Senior Scientist of Psychology
Jiuan S. Terman, Ph.D., Brown University

Clinical Assistant Professor
Karen Geelen, Ph.D., University of Kansas

Adjunct Associate Professors
Robert Bass, Ph.D., Brown University
Leila R. Kern, Ph.D., Columbia University
William Hartman, Ph.D., University of Florida

Adjunct Assistant Professors
Renée Briggs, Ph.D., Boston University

Myrna Libby, Ph.D., Brown University
Charles Hamad, Ph.D., University of Kansas

Adjunct Lecturer
Frederick Weiss, M.A., Northeastern University

THE PROGRAM OF GRADUATE STUDIES

Ph.D. Program

The Department of Psychology offers a full-time program of graduate studies and research in experimental psychology leading to the Ph.D. degree. Applicants are considered only for the doctoral program—the M.A. is granted in the course of progress toward the Ph.D. Since the Ph.D. degree is awarded in experimental psychology, accomplishment in research forms an essential and integral part of the program. Students may expect to collaborate with faculty in conducting research in one or more of the following broad areas: learning, motivation and behavior analysis; sensation and perception; neuropsychology and psychobiology; language and cognition; experimental personality and social psychology.

Desirable experience includes laboratory courses in psychology and allied natural sciences as well as courses in mathematics. Applications should be filed in the Department by March 1, complete with official transcripts, three letters of recommendation, and a personal essay. Scores on the Graduate Record Examinations and the Miller Analogies Test should be sent to the Graduate School of Arts and Sciences office.

Research assistantships and teaching assistantships offer students the opportunity to receive a tuition scholarship. In addition, those positions also carry a stipend in return for work performed in the Department. The Psychology Department endeavors to support, when possible, all graduate students requesting financial aid.

The first year of the program is uniform for all students. It includes four proseminars in advanced experimental psychology (language and cognition, neuropsychology, learning and motivation, sensation and perception), and two courses in quantitative methods. In addition, all students are expected to choose a research adviser and take an active part in one of the current research projects. Detailed descriptions of the current research projects are contained in the brochure, *Research in Psychology at Northeastern,* available on request.

At the end of the second academic year, each student's readiness for the doctoral program is determined on the basis of performance in the four proseminars and written examinations in the quantitative methods courses. Equal emphasis is placed on the quality of research.

After the first year, the structure of the doctoral program is flexible and assumes that the process of learning and scientific discovery must be individualized; however, the minimum requirements of the Graduate School of Arts and

Sciences for the Master's Degree and the Doctor of Philosophy Degree as established on page 20 apply. A wide variety of advanced seminars and courses is offered. Colloquia and in-house seminars bring students and faculty together to discuss ongoing research, often with visiting scholars from other institutions. Most important, students pursue their research projects under the guidance of their advisers. The advisers and projects available to students vary from year to year. Potential applicants are encouraged to visit the Department in order to discuss their interests with the faculty and to observe the program and facilities first-hand.

M.A. in Applied Behavior Analysis

The Department of Psychology also offers a full-time graduate program leading to a terminal M.A. degree in Applied Behavior Analysis. The program is jointly sponsored by Northeastern University and by the University-affiliated facility of the Eunice Kennedy Shriver Center for Research in Mental Retardation located at the Walter E. Fernald State School for the Retarded.

The two-year program provides the opportunity for students to prepare primarily for service-oriented clinical employment at professional and supervisory levels, in positions that relate to remedial treatment and programming for the retarded. Experience in clinical settings and in applied and laboratory research, along with the broad academic curriculum, also provides students with the opportunity to prepare for further graduate studies in human behavior and learning.

Desirable background includes academic and laboratory courses on human and animal learning, preferably with an operant-conditioning perspective, and some experience with retarded individuals. Applications should be filed by March 1, complete with transcripts, three letters of recommendation, a personal essay, and scores on the Graduate Record Examinations.

Support for M.A. students can include full tuition remission in return for performing teaching assistant functions for the Department. Also, field-placements, where available, allow paid employment for a maximum of twenty hours per week.

The program is conducted primarily at the Shriver Center and associated facilities. The minimum requirements of the Graduate School of Arts and Sciences for the Master's Degree as established on page 23 apply. The curriculum stresses the analysis of stimulus control and programmed teaching as solutions to the problems in learning and behavior management encountered by the retarded. In addition, courses encompass the broader interdisciplinary aspects of mental retardation, covering such topics as its biological bases, neurological and sensory impairments, multidisciplinary evaluation and treatment, and administration of services. Experimental design and research seminars help prepare students to conduct a number of applied projects and master's thesis research.

Supervised clinical experience is provided with different retarded populations and age groups, including those with motor and sensory handicaps, in a variety of settings. Most students are placed in positions where they receive supervi-

sory and administrative training. Additional experiences include interdisciplinary team evaluations using behavioral and traditional assessment methods; staff training in behavior management and training techniques; community experience via out-patient and home-treatment services, consultants to schools and clinics, and parent training; and laboratory research participation.

Most of the faculty have joint appointments in the Psychology Department of Northeastern University and in the Behavioral Sciences Department of the Shriver Center. The faculty and advisers are drawn primarily from the departmental areas of learning and personality (Bauman, Geelen, Mackay, Sidman, Stoddard, Zamansky) and from the staff of the Shriver Center. The M.A. students maintain an active involvement with the University and the parent Psychology Department through their teaching assistant functions, a number of required and elective courses, colloquia, in-house seminars, and informal exchanges with faculty and students.

Potential applicants may write for further information to the Department; they are also encouraged to visit the Shriver Center and the Department to discuss the program and their interests with the faculty and to see the facilities firsthand.

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

19.816, 19.817, 19.818, 19.819 General Experimental Psychology I, II, III, IV (4 q.h)
The departmental proseminar. Faculty lectures, student presentations, and discussions of the experimental literature in the following areas: learning, motivation, and behavioral analysis; sensation and perception; neuropsychology; language and cognition.

19.808, 19.809, 19.810 Quantitative Methods I, II, III
A survey of the quantitative methods used in experimental psychology, emphasizing applications of computer programming, theory of functions and relations, curve fitting, probability functions, set theory, and analysis of variance.

LEARNING AND BEHAVIORAL ANALYSIS

19.804 Experimental Design in Applied Research
Detailed study of experimental methods, emphasizing critical analysis of published research reports and the implementation of the methods in service settings. Students have the opportunity to learn and evaluate observational measurement and data-collection techniques. A feasible experimental design, with graphed actual or hypothetical data, must be written in the form of a scientific report.

19.811 Programmed Learning
A review of the history and theoretical and experimental bases of programmed instruction and errorless learning. Emphasis is placed on the detailed analysis of stimulus control—its measurement, and ways to produce it.

19.812, 19.813, 19.814, 19.824, 19.825 Programming Practicum I, II, III, IV, V
Students are expected to design, test, and evaluate instructional programs for teaching specific subject matter for remedial application to behavior problems and to test instruc-

tional theory. Supervision is provided by a weekly programming research and data seminar in collaboration with the student's adviser.

19.820 Mental Retardation Seminar
Interdisciplinary seminar taught by faculty from the several Boston-area universities associated with the University-affiliated facility. The role of each discipline in the care and treatment of retarded people is defined and coordinated with the functions of other relevant disciplines. Specialties include communication disorders (Emerson College), dentistry (Tufts University), medical disciplines (e.g., pediatrics, neurology, orthopedics, genetics—Massachusetts General Hospital, Harvard Medical Schoool), nursing (Boston University), nutrition (Framingham Teacher's College), occupational therapy and physical therapy (Sargent College of Boston University), social work (Boston University and Simmons College), sociology (Brandeis University), special education (Boston University), and psychology (Northeastern University).

19.821 Behavior Change in Institutions
A review of successful projects which have been carried out to provide effective remediation and rehabilitation in institutions for the mentally retarded, the juvenile delinquent, and the developing individual (schools).

19.835, 19.836, 19.837 Advanced Learning Seminars I, II, III
These seminars cover contemporary research in operant conditioning, with emphasis on relating the techniques of behavioral analysis to problems of reinforcement, motivation, comparative psychophysics, and physiological psychology.

19.922, 19.923 Learning Principles and Applications I and II
An analysis of principles from behavioral learning research and their application to the process of behavior change for learning, remediation, and treatment. Particular emphasis is on educational settings.

19.954 Administration of Mental Retardation Services
Presents comprehensive overview of general and specialized services for retarded individuals from organizational and administrative points of view. Issues in planning and initiating new programs, service delivery, staffing, and economics are covered. Visits to varied types of facilities focus on administrative concerns.

19.955, 19.956, 19.957 Systematic Inquiry in Applied Research I, II, III
Each student is expected to collect a comprehensive bibliography on a significant topic in applied behavior research and complete a thorough review via written and oral presentations. Emphasis is placed on the integration and analysis of experimental findings and theoretical foundations of the research area, the critical evaluation of current research, and the definition of potentially fruitful future work.

19.960, 19.961 Behavior Intervention I, II
Students are given instruction in behavioral intervention techniques. Emphasis is placed on the functional analysis of behavior.

SENSATION AND PERCEPTION

19.828 Contemporary Psychophysics
A mathematical study of signal-detection theory; human and animal psychophysical methods; theory of the ideal observer.

19.830 Psychoacoustics
This seminar deals with the relationship between sound and auditory perception. After five tutorial sessions on the physics and laboratory generation of sound, thresholds, masking, loudness, pitch, and sound localization, students are expected to lead discussions based on research papers in the psychoacoustic literature.

19.833 Perception
A detailed consideration of research in such areas as form, space, and pattern perception, recognition, and the effects of set and motivation on perception. Physiological concomitants of perceptual phenomena are considered.

19.860, 19.861, 19.862 Vision I, II, III
Seminars: classical and modern problems in vision. Recent journal articles provide primary source materials for discussion. Consideration is given to problems of stimulus specification, retinal structure, photochemistry, and psychophysical measures of sensitivity, color vision, and electrophysiology.

19.851 Electrophysiological Recording
Methods for recording electrophysiological activity from the human subject including electroencephalography, auditory and visual evoked potential recording, electroretinography—consideration of some of the principal findings that have been obtained with these methods and their importance for the interpretation of a variety of psychological phenomena.

NEUROPSYCHOLOGY

19.842 Brain and Behavior I
Prep. Admission to doctoral candidacy or permission of instructor. An introduction to basic methods of physiological psychology, including animal surgery, electrical stimulation of the brain, electrophysiological recording, and histological techniques. Students have the opportunity to gain experience in these methods by carrying out a limited research project during the semester. Enrollment limited to ten.

19.843 Brain and Behavior II
Prep. Admission to doctoral candidacy or permission of instructor. Selected topics in the neurophysiology of perception, emotion, motivation, learning and memory will be pursued in depth, with emphasis upon a critical evaluation of recent literature. Enrollment limited to fifteen.

19.880, 19.881 Sensory Psychophysiology I, II
Concentration on the anatomy and physiology of the various sensory systems and correlation of these data with psychophysical and perceptual concepts. Laboratory work is included.

19.844, 19.845, 19.846 Physiological and Comparative Psychology I, II, III
Seminars: a shared background, key concepts, and central issues in the field of physiological and comparative psychology.

19.915 Biological Bases of Mental Retardation
The course considers the relationship between biological malfunction, of the brain in particular, and the defective learning ability and other behavioral abnormalities which consti-

tute mental retardation. The aim is toward as comprehensive a survey as time permits. Exercises include actual case presentations as illustrative examples.

19.919 Neurochemistry and Behavior
This seminar examines different experimental approaches to the problems involved in uncovering the relationships between changes in brain activity and changes in behavior produced by drugs. Discussions center on current theorizing on the role of early experience, environmental factors, biological rhythms, and other facets in the determination of drug-induced behavioral changes.

19.952, 19.953 Neurological and Sensory Impairments Seminars I, II
Etiology, assessment, and diagnosis, clinical characteristics, and education of the mentally retarded with visual, hearing, and motor deficits are studied. In addition to discussion, experiences are provided in evaluation and remedial programming, via the application of operant techniques.

LANGUAGE AND COGNITION

19.870 Psycholinguistics
Seminar. In-depth analysis of research methods and findings in selected problems in the psychology of language, including developmental, anthropological, and experimental psycholinguistics.

19.871, 19.872 Cognition and Psycholinguistics
Research in cognition and psycholinguistics.

19.930 Seminar in the Structure of American Sign Language
This seminar is designed to introduce students to current issues in linguistic theory as well as to update them on the specific literature on ASL research. Focus is upon one particular area of linguistic theory as it relates to current ASL research, e.g., phonology, morphology, syntax, semantics or discourse (varies from year to year).

19.951 Child Language Development
Learning theory approaches to language acquisition are contrasted with psycholinguistic and neurogenic theories. Works of Skinner and Chomsky are analyzed, and implications for both normal and abnormal language development are discussed.

EXPERIMENTAL PERSONALITY AND SOCIAL PSYCHOLOGY

19.822, 19.823 Psychopathology I, II (4 q.h.)
A detailed consideration of the major forms of psychopathology, including the neuroses (obsessional states, hysteria, anxiety states, phobias), the psychoses (schizophrenia, mania, depression, paranoia), psychosomatics, sociopathy, conduct disorders, organic disorders, and mental retardation.

19.855 Social Psychology
Survey of theory and research in social psychology. Topics covered include attitude and attitude change, aggression, altruism, group processes, person perception, and social cognition.

19.901, 19.902, 19.903 Personality Theory and Research I, II, III
A survey of representative theoretical formulations of the normal personality and its devel-

opment, and an examination of experimental evidence bearing upon relevant concepts and assumptions (anxiety, repression, aggression, cognitive styles).

SPECIAL TOPICS

19.990 Special Topics in Psychology (maximum: 9 q.h.)

19.991 Thesis (6 q.h.)
Experimental work for the master's degree requirement.

19.993 Research Laboratory (1 q.h.)
Students and their faculty advisers discuss laboratory projects, current literature, theory, and applications.

19.995 Dissertation (0 q.h.)
Experimental and theoretical work for Ph.D. candidates.

sociology and anthropology

Professors
Morris Freilich, Ph.D., Columbia University
Elliott A. Krause, Ph.D., Boston University
Frank F. Lee, Ph.D., Yale University
Jack Levin, Ph.D., Boston University
Morton Rubin, Ph.D., University of North Carolina, Executive Officer
Earl Rubington, Ph.D., Yale University

Associate Professors
Ronald J. McAllister, Ph.D., Duke University, Chairperson
M. Patricia Golden, Ph.D., Cornell University, Director, Graduate Studies
Richard Bourne, Ph.D., Harvard University, J.D., Boston University
Wilfred E. Holton, Ph.D., Boston University
Debra R. Kaufman, Ph.D., Cornell University
Lila Leibowitz, Ph.D., Columbia University
Carol A. Owen, Ph.D., Cornell University

Assistant Professors
Arnold Arluke, Ph.D., New York University
Winifred Breines, Ph.D., Brandeis University
Marcia H. Bystryn, Ph.D., New York University
Paul G. Creelan, Ph.D., University of Chicago
C. Paul Dredge, Ph.D., Harvard University
Maureen Kelleher, Ph.D., University of Missouri, Columbia
Alan M. Klein, Ph.D., State University of New York, Buffalo
Thomas H. Koenig, Ph.D., University of California, Santa Barbara
Marlene Y. MacLeish, Ed.D., Harvard University
Bruce K. MacMurray, Ph.D., University of Iowa
Judith Perrolle, Ph.D., Brown University
Thomas M. Shapiro, Ph.D., Washington University, Associate Director, Graduate Studies
Carmen J. Sirianni, Ph.D, State University of New York, Binghamton

PROGRAMS OF STUDY

The Department of Sociology and Anthropology offers several degree programs: the Master of Arts in Social Anthropology, the Master of Arts in Sociology, and the Doctor of Philosophy in Sociology. With the Department of Foundations of Education in the Boston-Bouvé College of Human Development Professions, the Department also offers a concentration in sociology or social anthropology and education. The concentration is available to both M.A. and Ph.D. students and is intended for high school and community/junior college teachers in the social sciences. The Boston-Bouvé Graduate School offers a related set of programs: the Ed.M. in Social Sciences (option in sociology and

anthropology) and the CAGS in Social Sciences (option in sociology and anthropology). The Department also participates in the interdisciplinary doctoral program in Law, Policy, and Society (see page 102).

Admission

The general procedures and requirements for admission to the Graduate School of Arts and Sciences are set forth on page 19. For admission to the Department of Sociology and Anthropology, students must submit to the Department an application form, a one- or two-page personal statement, complete official transcripts for all undergraduate and graduate studies undertaken, and three letters of recommendation (at least two of which must be academic references). Either the aptitude test scores (verbal, quantitative, and analytical) on the Graduate Record Examination or Miller Analogies Test scores should be submitted to the Graduate School of Arts and Sciences Office. Candidates for the Ph.D. may submit a copy of their master's thesis or paper in lieu of the GRE or MAT scores. International students should also check page 20 of this bulletin.

Applications for admission are considered on a continuing basis for entry in any term specified by the applicant, provided the application is received at least two months prior to the beginning of the term in which the student wishes to matriculate. Students should be aware, however, that the sequencing of required courses is predicated on fall entry.

Each application is reviewed on its own merits. Any questions concerning the adequacy of the student's undergraduate background in sociology or anthropology are considered individually. In some cases, students may be asked to make up certain deficiencies before proceeding to the basic requirements. Exceptions are made with respect to procedural or substantive requirements on an individual basis if the circumstances seem sufficiently compelling.

In order to ascertain whether their interests coincide with those of the faculty, prospective candidates are urged to learn something about the scholarly interests and writings of the Department's faculty and to talk with graduate students currently in residence, in addition to examining the catalog and course offerings.

Financial Aid

There are several types of financial assistance available for graduate students in the Department and in the University. (See page 29.) The three types of awards described below are awarded by the Department. Students must apply for these awards as part of the regular application process. No separate application is required. While there can be no guarantee of financial aid, students should be aware that, in recent years, the Department has been able to provide either full or partial funding for most students with strong records.

Teaching Assistantships Most of the Department's teaching assistantships are awarded for thirty-nine weeks, although, dependent on undergraduate student enrollments, additional awards sometimes become available on a thirteen-week appointment basis. Teaching assistants are expected to work fifteen to

twenty hours per week assisting faculty in teaching undergraduates (e.g., conducting discussion sections, grading, etc.) Assistantships provide a tuition scholarship and an additional stipend. They are generally given to continuing students, going to new students only if they have had sufficient experience in teaching undergraduates or if all other promising continuing students have been supported. During the summer quarter, only a limited number of teaching assistantships are available. Students should note, however, that thirty-nine week awards provide tuition scholarships for the calendar year (see page 32).

Research Assistantships When departmental funds permit or when funds from outside sources become available, research assistantships may be awarded. Such awards are limited in number, usually two or three per year. When available, they provide students the opportunity to receive a tuition scholarship. In return for an additional stipend earned with the award, students are expected to work fifteen to twenty hours per week assisting faculty in research activities. In general, research assistantships, too, are more likely to go to continuing students. Awards made for thirty-nine weeks provide tuition remission for the calendar year (see page 32).

Tuition Assistantships These awards grant tuition remission only, in return for which a student will be called upon for service (e.g., grading, proctoring, bibliographic work, or other small research tasks) of up to eight hours per week. New students are more likely to be offered tuition assistantships. Students should note that the tuition received via this type of assistantship is classified as taxable income by the Internal Revenue Service.

Although the Department accepts applications for admission on a continuing basis, the application deadline for financial assistance in the following academic year is May 15. Applications received before March 15 are given priority. Decisions on financial assistance are made in the spring quarter, separate from decisions on admission. Thus, a student might hear about the admissions decision some time before hearing about the assistance decision.

As a general Department policy, students in the M.A. program are limited to four quarters of full-time funding, or the equivalent. Those students who enter the Ph.D. program with an M.A. or its equivalent are limited to six quarters of full-time funding, or the equivalent, by the Department. (This does not affect or apply to funding from other sources in the University, such as the Office of Financial Aid.) Those who enter the doctoral program directly from undergraduate school may be funded by the Department for up to ten quarters. (Again, this does not affect or apply to funding from other sources in the University or elsewhere.) Reappointment is contingent upon satisfactory performance in academic work and assigned duties.

Students should note the acceptance conditions and terms of appointment outlined on page 31. Students who hold assistantships are expected to devote full time to their studies and the duties of the award.

N.B. **Some of the requirements listed here for both the M.A. and Ph.D.**

have undoubtedly been modified. Please check with the Department and/or the Graduate School for the most recent information. This applies also to course offerings.

THE MASTER'S DEGREE

The Department offers graduate programs leading to a Master of Arts degree in Sociology or in Social Anthropology. Forty-two quarter hours of academic work completed with a B (3.0) average, or better, are required for the degree. The program usually consists of six required and six elective courses. With the approval of the Department, certain advanced undergraduate courses offered by the Department may be taken for graduate credit. In these, students must maintain better than a B (3.0) average.

Students are encouraged to fashion a program of studies best suited to their needs and abilities. To this end, all entering students should consult with the faculty advisers assigned to them. The faculty adviser not only helps the student to articulate interests and plan courses, but also suggests other faculty members whose areas of interest and competence intersect with those of the student and with whom the student might consult on a regular basis. A permanent relationship with the first adviser continues only if there exists a mutual interest in such a partnership.

For the Master of Arts in Sociology, students are generally required to take two one-quarter courses in theory (usually 21.805 and 21.806) and two or three in methodology (usually 21.810 and either 21.811 or 21.916/21.917, or 20.805/20.806). The statistics requirement may be satisfied by achieving at least a B in 21.813 or its equivalent. All students are strongly advised to take some work in social anthropology. Each of the required courses carries four quarter hours of credit. Enrollment in the master's level proseminar (21.965, 21.966, 21.967) is also suggested.

For the Master of Arts in Social Anthropology, students are generally required to take two one-quarter courses in theory (usually 21.805 and 20.802) and in methodology (usually 20.805 or 21.916 and 20.806 or 21.917), in addition to a basic course in anthropology (usually 20.808, 20.837, or 20.871). Other requirements are individually determined. All students are strongly advised to take some work in sociology. Each of the required courses carries four quarter hours of credit. Enrollment in the master's level proseminar (21.965, 21.966, 21.967) is also suggested.

Students who can demonstrate proficiency in any of the requirements need not take those particular courses, and should petition the graduate committee for an opportunity to demonstrate proficiency.

A master's paper is required and earns four quarter hours of credit. The student is required to work with a committee of three readers to produce a paper of publishable quality based on empirical or library research. It is expected that the full-time student will complete the master's paper no later than the end of the second year of study. Students having an interest in, and potential for, doctoral work are urged to take the qualifying examination during their second year of

residence, as its results are a major determining factor in deciding whether to encourage them to undertake doctoral study.

Deadlines for Submission of Master's Paper

A student must have substantially finished the master's paper as certified by the first reader on or before April 1 of the year in which the student expects to be awarded the degree. The oral defense is held at least two weeks before the commencement at which the degree is to be awarded. Those who miss the April 1 deadline normally have to wait until the subsequent fall quarter and should not expect that a defense can be set up much before November 1 of that quarter. A defense which might enable the student to receive a September degree can be arranged only if all members of the student's committee are available and agree to arrange a defense during the summer term.

THE DOCTOR OF PHILOSOPHY DEGREE

The Department offers the Ph.D. in Sociology. Only a limited number of students are enrolled in the Ph.D. program so as to provide highly personalized study and research training with individual supervision.

Admission

Applicants to the doctoral program should apply for admission in the year in which they expect to complete the requirements for the master's degree. Students who possess master's degrees earned in areas other than sociology are considered for admission on an individual basis. A tentative evaluation of the probability of advanced standing is made at the time the student is admitted. Final determination is made after the qualifying examination has been completed.

Students completing their master's degrees at Northeastern are considered for admission to the doctoral program only after the results of their qualifying examination have been evaluated. Students completing their master's degrees at other institutions are admitted with the expectation that they will take the qualifying examination at the first available opportunity.

Residence Requirement

The University's residence requirement can be satisfied by one year of full-time graduate work, or its equivalent, beyond the Master of Arts degree. If the student's M.A. degree is not in sociology, a longer period of residence is normally essential. Most students should expect to spend approximately two years, or the equivalent, in full-time graduate study beyond the requirements of the master's degree.

Qualifying Examination

Students are examined on their ability to interpret sociologically both readings and experience. Because the purpose of the examination is to evaluate the

manner in which students work with sociological concepts and structure answers, students are not tested on specifics or on material they have learned in particular courses. Rather, an effort is made to provide questions of sufficient breadth and interest to allow students to demonstrate their ability to think sociologically and to deal critically with a range of ideas.

The written part of the qualifying examination is given once a year in the fall term (usually early November). Students should recognize that, while diagnosis is the primary purpose of the qualifying examination, the examination is also reviewed critically. Thus, on the basis of the written examination, a pass, a conditional pass, or a no pass decision is rendered by the Graduate Committee and communicated to the student in writing.

For those students who pass, the written part of the examination is followed by an oral hearing, which is scheduled individually (usually in January). Strengths and weaknesses shown on the written examination are discussed with the student and suggestions made for remedying any weaknesses. In light of the examination performance, the student's future course is charted with the objective of helping the Department and the student determine the best course of action. Excessive weakness may lead to a recommendation that the student consider pursuing alternatives elsewhere.

Students who have completed, or who are about to complete, their master's degree in this Department may elect to submit a "State-of-the-Art" paper (see Comprehensive Requirement) in lieu of the qualifying examination.

The qualifying examination may be taken *only twice*.

Degree Candidacy

Degree candidacy is established in accordance with the general regulations of the graduate school—that is, the student must have completed forty quarter hours of acceptable graduate work and have passed the qualifying examination. To enter into degree candidacy in sociology, the student must also have a Master of Arts degree or its equivalent; three current letters of recommendation (at least two of which must be academic references) on file in the Department; and an advisory committee consisting of three faculty members from the Department.

Course Requirements

As prerequisites, all doctoral candidates are expected to have completed the core requirements for the Master of Arts in Sociology (21.805, 21.806, 21.810, 21.811, and 21.813—see page 161), or their equivalent. Students entering from another university may be required to take certain basic courses before proceeding with the doctoral program.

Generally, thirty-three hours of graduate work beyond the master's degree are required. Depending on background, experience, and performance, a greater or lesser number of formal courses may be required. Decisions on special cases will be made by the Committee on Graduate Studies (COGS), acting in conjunction with the student, the student's adviser, and the chair of the Department.

All doctoral students are required to include in their program of study the Doctoral Proseminar (21.970, 21.971, and 21.972), Current Issues in Social Research (21.812), and *one* course from the following: Contemporary Sociological Theories (21.807), Recent Developments in Sociological Theory (21.808), or Sociology of Knowledge (21.865). All doctoral candidates are strongly urged to take additional research courses, especially Multiple Regression (21.814) and, if they have not taken it previously, the Qualitative Methods sequence (21.916/21.917 or 20.805/20.806).

Students should register for Doctoral Dissertation (21.995) during each quarter that they are working on their dissertation. These registrations are fee-bearing (see page 28) but not credit-bearing.

Language Requirement

The language requirement may be satisfied by a reading knowledge of one language other than English in which there is substantial sociological literature or by a language needed for research in the student's area of specialization. Students must submit their choice of language to COGS for approval. The committee will arrange for a means of demonstrating language competency. A research language may be a computer language or the native language of a foreign student if these can be shown to be relevant to the student's dissertation research interests. The language requirement should be satisfied before students attempt to fulfill the comprehensive requirement.

Teaching Requirement

All doctoral candidates are required to teach. Students should register for 21.975 Tutorials in Teaching (for which a maximum of three quarter hours of credit may be counted toward the degree) during a term in which they are responsible for teaching a course. The COGS approves the tutorial credit, taking into consideration materials and evaluations supplied by the student.

Research Experience

All doctoral candidates are encouraged to acquire practical experience in social science research. This may be accomplished by working as a research assistant, through a directed study, or through some other arrangement acceptable to the candidate and the Committee on Graduate Studies.

Comprehensive Requirement

During the period of doctoral degree candidacy, each student must complete the comprehensive requirement, the purpose of which is to ensure that the student has breadth in sociological theory and methods and depth in at least one substantive area. The comprehensive requirement consists of three parts:

Part I Theory Examination. Students may choose between an in-house, closed-book exam (4–6 hours) and a take-home exam (24 hours).

Part II Methods Examination. Students may choose between an in-house, closed-book exam (4–6 hours) and a take-home exam (24 hours).

Part III A "State-of-the-Art" paper in a substantive area of the student's choice. This area may be that of the thesis. Students must submit their choice of area to the COGS for approval. State-of-the-Art papers may be submitted at any time.

To facilitate studying for the examinations (i.e., Parts I and II) lists of suggested readings, general guideline questions, and specific sample questions on theory and methods will be made available to students. The theory and methods examinations will be taken from these questions/materials, which will be revised from year to year.

The theory and methods examinations are each administered annually, during the spring quarter. So that students might know the results of one examination before attempting the other, there will be at least one month between the administrations of the two examinations. On the basis of the written examinations, pass/conditional pass/no pass decisions are rendered by the Graduate committee and communicated to the student in writing. For those students who pass, the written part of the examination is followed by an oral hearing, which is scheduled individually (usually in May or June). Strengths and weaknesses shown on the written examination are discussed with the student. For those students given a conditional pass on the written part of the examination, the outcome of the oral part of the examination is a final pass/no pass evaluation. The "State-of-the-Art" paper, likewise, is judged initially on a pass/conditional pass/no pass basis. Papers given a conditional pass must be rewritten within two months to address Committee concerns and be resubmitted for a final evaluation of pass/no pass.

Students may make only two attempts (at least a year apart) to complete each part of the comprehensive requirement. This means that students have two opportunities to pass the Theory Examination, two opportunities (again, at least one year apart) to pass the Methods Examination, and two opportunities to hand in an acceptable "State-of-the-Art" paper. Should any part of the comprehensive requirement not be passed on the second attempt (except under extraordinary circumstances) the student will be asked to leave the program.

The comprehensive requirement must be completed at least nine months before the commencement at which the Ph.D. is to be awarded. Until September 1985, students who entered the department before September 1983 may complete the comprehensive requirement in accordance with the guidelines outlined in either the 1980–82 or the 1982–84 GSAS bulletins. Students who enter the Department in September 1983 or later are required to adhere to the guidelines outlined in this or subsequent bulletins. From September 1985, all students must adhere to the guidelines in the 1982–84, or succeeding, GSAS bulletins.

Dissertation Proposal Hearing

The student must submit a prospectus describing the topic of the doctoral

dissertation, the methods of research, and the theoretical relevance of the problem. This prospectus is to be discussed with, and approved by, the dissertation committee consisting of the student's major adviser, two readers within the Department, and at least one reader from outside the Department. A formal hearing is scheduled at which the student assembles the committee and other interested faculty and students to discuss the proposed work critically. If refinement of the proposal is considered necessary, the student is required to modify the document to satisfy the committee. The revised prospectus is then filed with the Department. There is no alternative to the proposal hearing.

Deadlines for Considering a Doctoral Dissertation

The chairperson of the dissertation committee should be fully satisfied that a dissertation is substantially complete on or before April 1 of the year in which the candidate expects to defend the dissertation. A defense which might enable the student to receive a September degree can be arranged only if all members of the student's committee are available and agree to arrange a defense during the summer term.

Final Oral Examination

The dissertation may be defended only after completion of all other requirements for the doctoral degree. This oral defense is held approximately four weeks after the dissertation has been accepted by the dissertation committee, and at least two weeks before the commencement at which the degree is to be awarded.

JOINT PROGRAM IN SOCIOLOGY/ANTHROPOLOGY AND EDUCATION

For social sciences teachers in the public schools and in community/junior colleges, the Department of Sociology and Anthropology has combined its resources with those of the Department of Foundations of Education in the Boston-Bouvé College of Human Development Professions to offer a concentration in Sociology or Social Anthropology and Education. In addition to the basic requirements (twenty-four quarter hours) for the Master of Arts degree either in Sociology or in Social Anthropology, students who choose this option also take two sociology/anthropology electives (six quarter hours) and two education electives (eight quarter hours). The education electives are chosen from Area III courses and/or the Teacher Certification Program Courses (51.800 and/or 51.801). Students should consult the catalog of the Boston-Bouvé Graduate School for details. The final requirement is 21.844 Sociology and Anthropology in the Schools, also crosslisted as 50.844 (four quarter hours) in the catalog. Doctoral students may also choose to emphasize in their studies research and scholarship in the sociological and anthropological analysis of education.

NB. **Some of the requirements listed here for both the M.A. and Ph.D. have undoubtedly been modified. Please check with the Department and/or the Graduate School for the most recent information. This applies also to course offerings.**

DESCRIPTION OF COURSES

All courses carry three quarter hours of credit unless otherwise specified.

SOCIAL ANTHROPOLOGY

Many undergraduate courses in the 20.200 series may be offered for graduate credit. Students should check the current course announcements to take advantage of these offerings.

20.802 Theory (4 q.h.)
History of major contemporary orientations: evolutionary approaches, culture area, cultural ecology, functionalism, structuralism, and analysis of current status of these and related theories.

20.805, 20.806 Fieldwork I, II (4 q.h. each)
Data collection through participant observation and related anthropological methods. Data analysis and reports. (Not offered in years in which 21.916 and 21.917 are offered.)

20.808 Human Origins (4 q.h.)
An examination of the data on fossil remains and on contemporary primates which are essential for understanding human physical and behavioral evolution.

20.815 Tribal Societies and Culture
The structures and institutions of bands, tribes, and chiefdoms: comparative and functional studies of tribal societies and the dynamics of change under contact situations.

20.820 Peasants
Institutions of peasant society. The structure of traditional civilizations and the interrelations between urban and local communities: comparative and functional analysis of the peasant community and the dynamics of change from peasant to post-peasant and industrialized societies.

20.825 Language and Communication
Human communication, including language. Theories of the evolution of langauge and the application of models derived from the study of language to other aspects of behavior.

20.827 The Anthropology of Music
The examination of music in a prehistoric and cross-cultural perspective, with emphasis on ethnomusicology and the comparison of western and nonwestern musical culture. Functions and social contexts of musical composition and performance; the ethnography of musical performance groups; the analysis of music as a form of communication.

20.828 Aggression
Concepts of aggression as they have been used in evolutionary and comparative anthropological formulations. Professional and popular publications in anthropology, ethology, and psychology are analyzed.

20.830 Individual and Culture
Examination of current theory and method in the study of the interplay between personality and culture. Contributions by various disciplines are discussed.

20.831 Culture and Mental Illness
Discussions and analyses of the nature and meaning of culture, the role of culture in personality formation, culture and anxiety, anthropological approaches to the "normal" and the "abnormal," and the question, "Is mental illness psychological fact or cultural fiction?"

20.835 Kinship and Social Structure
A variety of kinship systems and their terminological and structural components and the way in which their systems articulate with other social institutions.

20.837 Family in Evolutionary Perspective (4 q.h.)
The emergence of family from pre-human patterns, its biological and behavioral components, and its cross-cultural variations examined from an evolutionary perspective.

20.840 Urban Ethnography
Selected problems in anthropological studies in urban societies.

20.845 Visual Anthropology
Explores the anthropologist's use of film to gather information and analyze cultural subsystems. In addition to reading about and viewing films on particular populations, students are introduced to the field through a laboratory aspect of the course involving the use of tape and video equipment.

20.850 Anthropology of Religion
Nature and institutionalization of primitive, ancient, and contemporary religions. Exploration of religious concepts and movements in relation to social, religious, and political organization.

20.852 The Anthropology of Law and Conflict
Settling disputes in stateless societies; forms and mechanisms of social control; law as an indicator of cultural and social norms; the study of conflict resolution as an ethnographic tool. Some field research and analysis is required.

20.855 Economic Anthropology
Types of economic systems in simple societies: reciprocal, redistributive, market exchange; economic relations as part of social relations; land-tenure systems, credit systems, savings mechanisms. The transition from subsistence to cash economics.

20.857 Social Change and Economic Development
Selected studies of processes of transformation and modernization in nonindustrial societies.

20.860 Cultural Ecology
Examines human adaptation to environment and the effect of different human adaptations on natural systems.

20.871 Evolution of Society (4 q.h.)
The development of political and economic institutions beginning with foraging societies and the sexual division of labor: specialization, social stratification and the emergence of civilization.

20.880, 20.881, 20.882, 20.883, 20.884, 20.885
Ethnographic area courses (New World Indian, African, Indian, Chinese, and others) are offered as resources permit.

20.950, 20.951, 20.952 Directed Study in Social Anthropology (Maximum: 9 q.h.)
Reading and empirical research in social and cultural anthropology supervised by members of the anthropological staff.

20.980, 20.981, 20.982, 20.983 Contemporary Issues in Social Anthropology (3 q.h. each)
Contemporary issues in the field of anthropology. Supervised readings and written reports on special programs.

20.990 Seminar (Maximum: 9 q.h.)
Discussion of selected topics in the field of anthropology.

20.991 Master's Paper in Social Anthropology (4 q.h.)
Empirical or library research meeting the criteria for publication in a professional journal. *Supervision by members of the department.*

SOCIOLOGY

Many undergraduate courses in the 21.200 series may be offered for graduate credit. Students should check the current course announcements to take advantage of these offerings.

21.805 Foundations of Social Theory I (4 q.h.)
The classic theorists (Durkheim, Weber, Marx, Simmel, and others) are considered intensively.

21.806 Foundations of Social Theory II (4 q.h.)
An intensive analysis of modern theorists from the 1930s onward (Parsons, Merton, Levi-Strauss, Goffman, Homans, Schutz, Garfinkel, Ricoeur, Lukacs, Habermas, and others). The social and historical context of theory construction is stressed.

21.807 Contemporary Sociological Theories
Analytic treatment of major contemporary theories such as functionalism, conflict, neo-Marxism, and others. *Prep. 21.805 and 21.806 (or equivalent) or consent of the instructor.*

21.808 Recent Developments in Sociological Theory
New horizons in theory and the relation of theory to research. Topics to be selected and announced by the instructor. *Prep. 21.805 and 21.806 (or equivalent) or consent of the instructor.*

21.810 Introduction to Research Methods (4 q.h.)
A survey of methods of social research including field study and participant observation techniques, survey techniques, interviewing and questionnaire construction, sampling procedures, experimental design, content analysis, and use of available data.

21.811 Quantitative Research Methods
Quantitative techniques of analysis. Students are expected to conduct individual research project. *Prep. 21.810 (or equivalent) or consent of the instructor.*

21.812 Current Issues in Social Research
Selected topics in methods of social research are examined. *Prep. 21.810 and 21.811 (or equivalent) or consent of the instructor.*

21.813 Statistical Methods for Sociologists (4 q.h.)
Detailed introduction to statistical methods relevant to sociology. Topics include tabular analysis, non-parametric statistics, analysis of variance, regression analysis, path analysis, measures of association, estimation and univariate and multivariate hypothesis testing. A knowledge of elementary statistical theory is presumed.

21.814 Multiple Regression in Sociological Analysis
This course focuses on techniques of sociological analysis based on multiple regression, e.g., use of coded variables, trend analysis, covariance analysis, model testing. *Prep. 21.811 and 21.813 (or equivalents).*

21.817 American Society
Study of the development of, and the changes in, the institutional structure of American society in comparison with certain other social systems.

21.820 Sociology of Deviant Behavior
Applications of sociological concepts and principles to some problems of social disorganization in industrial societies. Analysis of such problems as suicide, prostitution, physical handicaps, unemployment, alcoholism, sexual deviance, and gambling.

21.822 Sociology of Poverty
An analysis of sociological perspectives on causes of poverty, public views on poverty and institutional responses to poverty. A concern with policy issues and implementation of policies is emphasized. For advanced students in the social sciences and in the various human service schools in the University.

21.824 Sociology of Alcoholism
The course examines four general problem areas: the conditions under which people categorize others as alcoholics; the processes by which persons so defined are assigned deviant status and assume appropriate roles and self-images as alcoholics; the development of drinking careers and their relationship to deviant subcultures; and the social situations in which people transform their deviant identities as alcoholics. The course applies organizational analysis to the development and changing network of alcoholism treatment services and tries to develop some tentative generalizations on the social organization of alcoholism.

21.827 Sociology of Delinquency
Social and social psychological factors of delinquency and their implications for prevention, rehabilitation, and treatment.

21.832 Sociology of Crime and Justice
A sociological and legal analysis of the criminal justice system, concentrating on police

and law enforcement; plea-bargaining; courtroom research and trial strategies; sentencing; and prisoners' rights and corrections. The relationship between race, social class and crime is also considered, as are the sociological explanations of crime causation.

21.835 Theories of Criminology
Theories and philosophies underlying various correctional systems. Schools of thought in criminology and penology. Theoretical approaches to the crime and delinquency problem from the beginnings of criminology to current thinking.

21.837 Sociology of Law
Fundamentals of law. The concept of social control. Order and law. Consensus and conflict. Analysis of the normative-formative influences of law. Mores and morals. The concept of justice. Analysis of some legal institutions.

21.840 Sociology of Medicine
Social aspects of illness and medicine, historically and cross-culturally. Illness and the medical profession in modern society and their structural settings: the community, the hospital, the medical school. Research studies in the field are examined critically and problems for future research specified.

21.841 Sociology of Aging
A critical examination of the field of social gerontology, the nature and roots of ageism and topics such as elderly housing, life study, institutionalization, health care, retirement, leisure, and senior power.

21.842 Processes of Aging
Socioeconomic and social psychological consequences of aging are examined from the perspective of health-care providers. A major part of the course focuses directly on the biological changes entailed in aging and the appropriate medical management of geriatric patients. Open to students expected to provide health-care services to geriatric patients.

21.843 Sociology of Education
The structure and functioning of educational institutions. Student, faculty, and administrative perspectives. Emphasis is placed on the role of education in processes of socialization, social mobility, social change, and social control.

21.844 Sociology and Anthropology in the Schools (4 q.h.)
(Listed as 50.844 in the Boston Bouvé Graduate School catalog)
The course offers a setting in which current and prospective teachers of sociology and anthropology at the pre-college and community college levels have the opportunity to analyze curricula in their fields and consider alternative rationales for various approaches to teaching sociology and anthropology at these levels. Study also focuses on the potential uses of sociological and anthropological concepts in analyzing and solving educational problems. Students are expected to present either a course or unit they have prepared or a project they have planned or conducted utilizing a sociological or anthropological perspective.

21.847 Formal Organizations: Administration and Structure
Analysis of the goals and functions of modern organizations. Aspects of bureaucratization are examined within business firms, public institutions, and private associations.

21.850 Sociology of Occupations and Professions
The relations between the occupations and professions and society. Special topics may include occupational stratification, professional group behavior, recruitment and socialization of occupations and professions, and political activism.

21.851 Sociology of Work
The course is designed to examine the effects which the social organization of work has on the lives of workers as well as on the structure of society.

21.854 Comparative Socialism
Analysis of twentieth century socialism from a comparative perspective. The variety of "socialisms" that have developed in the Soviet bloc, China, Yugoslavia, and Cuba, as well as Western social democracy (Sweden) and Eurocommunism. Topics include political structure, class relations, industrial organization, cultural formations, dynamics of change, and democratization.

21.855 Political Sociology
Sociological analysis of power relations and power systems with special attention to the bases of political power, processes of change in power, and the part played by violence and revolutionary movements.

21.856 Social Movements
A study of various movements for social change from all points of the political spectrum. Special attention will be given to the structural context, as well as to such processes of social movements as social base, leadership, strategy and organization.

21.857 Economic Sociology
The role of economic factors in the social process. Consideration is given to both classic economic theory and its impact on classic social theory, and the potential interrelations between modern economic theory (especially model-building approaches) and general sociological problems.

21.860 Intergroup Relations
The relations between various racial, national, cultural, and religious groups with emphasis on historical development. Particular attention is paid to American society with its specific problems of adjustment and assimilation.

21.861 Sociology of Prejudice and Discrimination
A study of the characteristics, causes, and consequences of prejudice and discrimination, with particular reference to American society.

21.862 Race and Ethnic Relations: A World Perspective
Cross-cultural analysis of race and ethnic relations in western and non-western societies. Explanations of race and ethnic relations in terms of contemporary developments, world problems, and ideological conflicts.

21.863 Sociology of Religion
A sociological analysis of religious institutions and experiences in their historical and contemporary content. Religion context and political context are considered.

21.865 Sociology of Knowledge
The relationship between the social base of a society and its intellectual products. The viewpoints of authors such as Marx, Weber, Mannheim, G. H. Mead, the Neo-Marxian, and other modern schools are considered. *Prep. 21.805 and 21.806 (or equivalent), or consent of the instructor.*

21.867 Sociology of Art
Examination of the practices which lead to the production of artistic meaning; the relationship of art to society; the nature of artistic communities, their relationship to patronage systems and art markets; the manner in which these systems are rooted in particular social and historical contexts.

21.868 Popular Culture
Both pluralist and mass culture theories are inadequate in explaining mass popular culture; therefore, a primary objective of the course it to develop and refine an efficient theoretical framework. Problems to be addressed include the relationship between popular culture, high culture, and folk culture and the genesis and role of the mass media in industrial societies. The course also focuses on empirical research in several forms of popular culture, including sports, rock music, and science fiction novels. Organization and impact of market, stylistic shifts, and the viability of criticism are examined.

21.870 The Family
Social structure and social functions of the family as a social institution. Relations between the family and other institutions in society are examined comparatively and historically.

21.875 Women, Men, and Social Change
The Industrial Revolution and the corresponding changes in the labor force and patterns of domestic life have altered the sexual division of labor. In post-industrial society new institutional forms are recasting personal relations. The course examines these forces of social change and their impact on sex roles.

21.880 Community Analysis
Ecological theories of human relations with the physical environment. Development of the concept of, and discussion of methods for, community study. Comparison between rural communities and urban neighborhoods. Discussion and evaluation of community action programs.

21.881 Community Research Laboratory

21.885 Urban Sociology
Theories of the development of urban life. Comparisons between pre-industrial and industrialized urban areas. Methods for the study of urban social structure and change. Evaluation of contemporary metropolitan action programs.

21.886 Seminar in Urban Social Policies
Social science theories and methods evaluated from the perspectives of urban affairs. *Consent of instructor.*

21.887 Sociology of Policy, Planning, and Evaluation
A general introduction to the social, political, and economic factors affecting policy forma-

tion and the eventual success or failure of social programs in health, education, welfare, and urban planning. Stress on evaluation of policy alternatives and planning problems. For advanced students in the social sciences and in the various human service schools of the University.

21.888 Metropolitan and Regional Issues
Comparative analyses of problems, policies, programs, and activities associated with metropolitan and regional life. Includes assessment of values, institutions, networks, interest groups, decision making, service delivery, growth and development, environment, equity, and integration. Case studies in societal context.

21.889 Boston Seminar
A case study in urban development, including the evaluation of environmental and historical circumstances, demands for services, response to events, programs. Basis for value systems of Yankees, ethnics, and cosmopolitans. Impact on downtown and neighborhood relations. Metropolitan prospects.

21.890 Middle East Area Study
Sociocultural analysis of the Middle East. Ecological, structural, institutional, and normative factors in nomadic, rural, and urban life. Comparative regional analysis.

21.895 Latin American Societies
Study and analysis of selected Latin American societies with particular attention to such countries as Cuba, Mexico, Peru, and Brazil. Emphasis on urbanization and industrialization, social and political change.

21.900 Issues in Social Psychology
Human behavior and theories of self from a sociological and psychological perspective. Special consideration of interpersonal relations, socialization, and symbolic interaction.

21.910 The Sociology of Science
Selected topics dealing with interactions between science and society.

21.912, 21.913 Experimental Methods in Social Research I, II
Experimental design and laboratory methods in sociology. The small groups laboratory is treated as a setting for testing sociological theory. The emphasis is upon techniques and problems in the creation and manipulation of social variables in the laboratory situation, although the techniques of the natural experiment are also considered.

21.914 Rhetoric in Sociology
Critical examination of the conventional forms of sociological writings. How conventions differ by theoretical perspective and paradigm.

21.915 Seminar in Symbolic Interaction
The social psychology of groups as found in the works of Mead, Becker, Blumer, Goffman, and others.

21.916, 21.917 Seminar in Qualitative Analysis I, II (4 q.h. each)
Qualitative techniques of analysis. Social-structure process and meaning in interacting groups. Each student is expected to study a face-to-face group by means of participant

observation using symbolic interaction concepts. (Not offered in years in which 20.805 and 20.806 are offered.)

21.920 Social Stratification
Theories of inequality between groups in historical perspective, from classical to modern industrial times. Discussion and evaluation of sociological research in social stratification with regard to different social and cultural groups.

21.930, 20.930 Social and Cultural Change S, A
Two-quarter course in conjunction with Anthropology.
Analysis of the changing patterns in social, economic, and political institutions. Modern social trends are discussed.

21.940, 21.941 Social Control I, II
Seminar in research, theories, and methods in the sociology of social control.

21.950, 21.951 Seminar in Social Structure I, II
Seminar relating current theories and research in sociology, social psychology, and social anthropology.

21.960, 21.961, 21.962 Seminar on Socialization I, II, III
I) Instructor reviews theories and findings in organizational socialization. II) Students are expected to design studies in organizational socialization. III) Students are required to present results of their studies. *Not open to first year students.*

21.965, 21.966, 21.967 Proseminar (1 q.h. each)
This course is suggested for entering students. The focus is on issues related to graduate student life and expectations, professional and career choices, and works in progress. Students have an opportunity to explore more informally, with each other and with various faculty members, some of the important issues in the profession.

21.970, 21.971, 21.972 Doctoral Proseminar (1 q.h. each)
This course is required of all doctoral candidates and is designed to help socialize them for participation as professional sociologists and anthropologists. Topics discussed include the nature of intellectualism and the functions of an intellectual in society today, the university as a structure and as a community of scholars, the nature of professional organizations, teaching sociology and anthropology, the organization of sociological and anthropological research, ethics in the profession, the nature of applied sociological and anthropological work. The course offers participants the opportunity to acquire practical experience in self-presentation and giving colloquia. *Prep. 21.812 and 21.807 or 21.808 or 21.865 or consent of the instructor.*

21.975 Tutorial in Teaching (3 credits maximum)
Discussion of issues and problems in teaching. This is a required course for all doctoral candidates and should be taken during a quarter when the student has major responsibility for designing and executing a course in either sociology or anthropology. *Open to doctoral candidates only.*

21.980, 21.981, 21.982, 21.983 Contemporary Issues in Sociology (3 q.h. each)
Contemporary issues in sociology. Supervised readings and written reports on special problems.

21.990 Seminar (Maximum: 9 q.h.)
Discussion of selected topics in the field of sociology.

21.991 Master's Paper in Sociology (4 q.h.)
Empirical or library research meeting the criteria for publication in a professional journal. *Supervision by members of the Department.*

21.992, 21.993, 21.994 Directed Study in Sociology (Maximum: 9 q.h.)
Reading and research under the direction of a faculty member. *Open to doctoral candidates only.*

21.995 Doctoral Dissertation (No credit)

the governing boards and officers of the university

THE CORPORATION

Julius Abrams
William T. Alexander
William F. Allen, Jr.
**Diana J. Auger

*Vincent Barletta
Allen G. Barry
Lincoln C. Bateson
*Roy H. Beaton
†F. Gregg Bemis
Beverly Ann Bendekgey
Robert P. Berkowitz
Alfred M. Bertocchi
Gerald W. Blakeley, Jr.
S. Whitney Bradley
Melvin B. Bradshaw
Rexford A. Bristol
Edward W. Brooke
*Frederick L. Brown
†George R. Brown
William L. Brown
William H. Bruce, Jr.
John L. Burns
Hyman H. Burstein
Victor C. Bynoe

*Louis W. Cabot
*Norman L. Cahners
*Thomas E. Cargill, Jr.
*Richard P. Chapman
Richard P. Chapman, Jr.
Robert F. Chick
Vessarios G. Chigas
Logan Clarke, Jr.
Livingstone N. Coakley

*David H. Cogan
Abram T. Collier
T. Paul Connolly
James J. Costello
Edward Creiger
H. James Crossan, Jr.

Roger C. Damon
Nelson J. Darling, Jr.
Melanie Dean
(Melanie C. Berger)
Virginia Schenkelberger Devine
William O. DiPietro
Alfred di Scipio
Mrs. Estelle Dockser
Dorothy Dodge
**William R. Driver, Jr.

William S. Edgerly
*William Elfers
*Byron K. Elliott
*William P. Ellison
Robert Erickson

*Frank L. Farwell
Joseph D. Feaster, Jr.
*James V. Fetchero
*Eldred L. Field
Phil David Fine
Joseph F. Ford
Albert S. Frager
Brenda J. Furlong

Murray J. Gart
Paul W. Glennon
*Lloyd S. Glidden, Jr.

---

*Member of the Board of Trustees
**Honorary Trustee
†Lifetime Trustee, Emeritus

John L. Grandin
**Donald B. Guy

*Allan M. Hale
Edmund Blair Hawley
Michael E. Haynes
Donald P. Hearth
James S. Hekimian
William Hellman
*Ernest Henderson III
Joseph E. Heney
James S. Herbert
Arnold S. Hiatt
Richard D. Hill
Thomas Hollis, Jr.
D. Brainerd Holmes
Robert W. Holmes
Hartwell G. Howe
John S. Howe
Howard M. Hubbard
*Carl R. Hurtig

Richard P. Johnson
*Robert L. Johnson
*Henry C. Jones

*George S. Kariotis
Walter B. Kelley
†Frances Kenerson
Edward M. Kennedy
Fenton G. Keyes
Calvin A. King
†Asa S. Knowles
Harvey C. Krentzman

Evelyn Lane
*John P. LaWare
*Joseph C. Lawler
Maurice Lazarus
Elma Lewis
*Kenneth A. Loftman
Edward A. Loring
*John Lowell
*Diane H. Lupean

*Roderick M. MacDougall
Robert C. Marini
Evelyn Marran

**Lawrence H. Martin
M. Dorothy Massey
*George J. Matthews
Walter E. Mattson
*J. Edwin Matz
Peter H. McCormick
William J. McCune, Jr.
John G. McElwee
Katherine Seay McHugh
Percy M. McIntosh
Dominic Meo, Jr.
William C. Mercer
Don G. Mitchell
Donald H. Moore
Frank E. Morris
James A. Morris
**Stephen P. Mugar

N. Lawrence Nagle
William H. Nichols, Jr.
Kathryn M. Nicholson

Bernard J. O'Keefe
Stanley C. Olsen
James H. Orr
Ara Oztemel

*Augustin H. Parker
Edward S. Parsons
*Amelia Peabody
Theodore R. Peary
Lawrence T. Perera
Nicholas V. Petrou
Edward E. Phillips
*Thomas L. Phillips
Edward D. Phinney
Rudolph F. Pierce
Jerome M. Powell
Albert Pratt
John F. Prendiville
Peter W. Princi
*William J. Pruyn
George Putnam

Blanche M. Quaid
*Francis J. Quirico

---

*Member of the Board of Trustees
**Honorary Trustee
†Lifetime Trustee, Emeritus

William H. Raye, Jr.
Kathleen M. Rice
D. Paul Rich
Robert Riesman
R. Earl Roberson
Daniel J. Roberts
†Dwight P. Robinson, Jr.
Ralph B. Rogers
Ronald L. Rossetti
*Kenneth G. Ryder

Ernest J. Sargeant
David T. Scott
Donald W. Seager
Sydney Shaftman
James L. Shanahan
Robert E. Siegfried
*Dorothy M. Simon
Philip A. Singleton
Paul D. Slater
**Donald W. Smith
*Farnham W. Smith
*Charlotte B. Smith
*George A. Snell
O. Phillip Snowden
*Bernard Solomon
Robert C. Sprague
Milton Stern
David B. Stone
Ruth S. Stuart
H. Patricia Taylor
Lawrence I. Templeman
Charles H. Tenney II
Almore I. Thompson
Milton A. Thompson
W. Nicholas Thorndike
Alan D. Tobin
*D. Thomas Trigg
Paul E. Tsongas
Joseph F. Turley
†Chaplin Tyler

Samuel Wakeman
Martin F. Walsh
*An Wang
Lloyd B. Waring
James L. Waters
David T. Wendell
William C. White
*Robert H. Willis

Richard W. Young

**Alvin C. Zises

---

*Member of the Board of Trustees
**Honorary Trustee
†Lifetime Trustee, Emeritus

OFFICERS OF THE CORPORATION AND BOARD OF TRUSTEES

Robert H. Willis, Chairman
Norman L. Cahners, Vice Chairman
Frank L. Farwell, Vice Chairman
Farnham W. Smith, Vice Chairman
D. Thomas Trigg, Vice Chairman–Finance
Philip C. Boyd, Secretary
Byron K. Elliott, Honorary Chairman
William R. Driver, Jr., Honorary Vice Chairman
Dwight P. Robinson, Jr., Honorary Vice Chairman

Board of Trustees

Class of 1982
Frederick L. Brown
David H. Cogan
Frank L. Farwell
Lloyd S. Glidden, Jr.
Allan M. Hale
Henry C. Jones
J. Edwin Matz
Farnham W. Smith
George A. Snell
D. Thomas Trigg

Class of 1983
Vincent Barletta
Roy H. Beaton
Louis W. Cabot
Byron K. Elliott
Kenneth A. Loftman
John Lowell
Roderick M. MacDougall
Augustin H. Parker
Francis J. Quirico
Charlotte B. Smith
An Wang

Class of 1984
Thomas E. Cargill, Jr.
Eldred L. Field
Robert L. Johnson
George S. Kariotis
Diane H. Lupean
Amelia Peabody
Thomas L. Phillips
William J. Pruyn
Dorothy M. Simon
Bernard Solomon
Robert H. Willis

Class of 1985
Norman L. Cahners
Richard P. Chapman
William Elfers
William P. Ellison
James V. Fetchero
Ernest Henderson III
Carl R. Hurtig
John P. LaWare
Joseph C. Lawler
George J. Matthews
Ruth S. Stuart

Ex Officio
††Kenneth G. Ryder

Honorary Trustees
Diana J. Auger
William R. Driver, Jr.
Donald B. Guy
Lawrence H. Martin
Stephen P. Mugar
Donald W. Smith
Alvin C. Zises

Lifetime Trustees, Emeriti
F. Gregg Bemis
George R. Brown
Frances Kenerson
Asa S. Knowles
Dwight P. Robinson, Jr.
Chaplin Tyler

††President of the University

ADMINISTRATIVE ORGANIZATION

Officers of the University

Arthur W. Brodeur, B.S., *Vice President for Public Affairs*
John A. Curry, A.B., Ed.M., Ed.D., *Senior Vice President for Administration*
Edmund L. Deltano, B.A., *Vice President for Finance*
Asa S. Knowles, A.B., A.M., L.L.D., Litt. D., Sc.D., D.B.A., Sc.D. in Bus. Ed., *Chancellor*
Melvin Mark, B.S., M.S., Sc.D., *Senior Vice President for Academic Affairs and Provost*
John Martin, B.S., M.B.A., *Vice President for Business*
John D. O'Bryant, B.S., M.Ed., *Vice President for Student Affairs*
Eugene M. Reppucci, Jr., B.S., M.Ed., *Vice President for University Development*
Daniel J. Roberts, B.S., M.B.A., Ed.M., *Senior Vice President-Treasurer*
Kenneth G. Ryder, A.B., M.A., L.H.D., *President*
Royal K. Toebes, B.S., M.B.A., *Vice President for Alumni Development*
Roy L. Wooldridge, B.S., Ed.M., *Vice President for Cooperative Education*

Academic Deans, Directors of Schools, and General Administrative Officers

Richard Astro, B.A., M.A., Ph.D., *Dean of the College of Arts and Sciences*
Maryanne G. Billington, A.B., M.B.A., *Assistant Dean and Director of the Graduate School of Business Administration*
David H. Blake, A.B., M.B.A., Ph.D., *Dean of the College of Business Administration*
Philip T. Crotty, A.B., A.M., M.B.A., Ed.D., *Vice Provost*
Martin Damian, B.S., *Bursar*
Charles Devlin, B.S., M.Ed., *Dean of Student Financial Services*
Theodore N. Ferdinand, B.S., M.S., Ph.D., *Director of the Graduate Program in Criminal Justice*
Clifford J. Fralen, B.S., M.S.E., M.B.A., *Director of the Physical Plant*
William A. Frohlich, B.A., *Director of University Publishing Group and Director of University Press*
Job E. Fuchs, M.D., *Director of Health Services*
Joseph M. Golemme, S.B., M.A., C.P.A., *Director of the Graduate School of Professional Accounting*
Thomas E. Hulbert, B.Mgt.E., M.S., *Director of Lincoln College and Associate Dean of Engineering*
Ellen S. Jackson, B.A., Ed.M., C.A.G.S., *Dean and Director of Affirmative Action*
John W. Jordan, B.S., M.Ed., *Dean of University College*
Paul M. Kalaghan, A.B., M.S., Ph.D., *Dean of the College of Computer Science*

Christopher F. Kennedy, A.B., Ed.M., *Dean of Administration*
Philip LaTorre, B.S., M.S., *Dean of Personnel Services and Director of Environmental Health*
Paul M. Lepley, B.S., M.Ed., Ed.D., *Dean of Boston-Bouvé College of Human Development Professions*
Juanita O. Long, B.S.N., M.S.N., C.A.G.S., *Dean of the College of Nursing*
Harold Lurie, B.S., M.S., Ph.D., *Dean of the College of Engineering*
Philip McCabe, B.A., M.Ed., *Dean of Admissions*
Michael C. Meltsner, A.B. LL.B., *Dean of the School of Law*
Roland H. Moody, A.B., B.L.S., *Director of the University Libraries*
Edmund J. Mullen, B.A., M.Ed., *University Registrar*
J. Edward Neighbor, B.S., M.S., Ph.D., *Director of the Graduate School of Arts and Sciences and Associate Dean of the College of Arts and Sciences*
John L. Neumeyer, B.S., Ph.D., *Director of the Graduate School of Pharmacy and Allied Health Professions*
Paul M. Pratt, B.S., M.Ed., *Dean of the Department of Cooperative Education*
John Proakis, B.S., M.S., Ph.D., *Associate Dean of Engineering and Director of the Graduate School of Engineering*
Edward W. Robinson, B.S., Ed.M., *Dean of Students*
Norman Rosenblatt, A.B., Ph.D., *Dean of the College of Criminal Justice*
Jeanne L. Rowlands, B.A., B.S., M.A., *Director of Women's Athletics*
Gerald E. Schumacher, Pharm.D., M.Sc., Ph.D., *Dean of the College of Pharmacy and Allied Health Professions*
Karl Weiss, B.S., Ph.D., *Vice Provost*
Virgil A. Wood, A.B., B.D., C.A.S., Ed.D., *Dean and Director of the African-American Institute*
Joseph Zabilski, B.S., *Director of Men's Athletics*

GENERAL UNIVERSITY COMMITTEES

Academic/Administrative Council*

Kenneth G. Ryder, Chairman
John A. Curry, Vice Chairman
Melvin Mark, Vice Chairman
Barbara F. Burke, Secretary

Richard Astro
David H. Blake
Arthur W. Brodeur
Charles W. Coffin
Philip T. Crotty
Edmund L. Deltano
Clifford J. Fralen
Humberto F. Goncalves
Ellen S. Jackson
John W. Jordan
Paul M. Kalaghan
Christopher F. Kennedy
Roland E. Latham
Philip LaTorre
Paul M. Lepley
Juanita O. Long
Harold Lurie
Kathryn Luttgens
John A. Martin
Philip R. McCabe
Michael C. Meltsner
Christopher Mosher
John D. O'Bryant
Donald G. Porter
Paul M. Pratt
Eugene M. Reppucci, Jr.
Daniel J. Roberts
Edward W. Robinson
Norman Rosenblatt
Gerald E. Schumacher
Arthur D. Smith
Royal K. Toebes
Karl Weiss
Roy L. Wooldridge

* Two faculty representatives to be selected by the Faculty Senate Agenda Committee.

The Faculty Senate

*Melvin Mark, Presiding Officer

George G. Adams
Samuel J. Bernstein
*David H. Blake
Franklyn K. Brown
Richard L. Canale
Holly M. Carter
Sangit Chatterjee
*John A. Curry
Arthur Davis, Jr.
Charles H. Ellis, Jr.
Steven E. Eriksen
Mary Florentine
Norbert L. Fullington
Harold M. Goldstein
Robert A. Gonsalves
Peter J. Graham, Jr.
Bart K. Gruzalski
Jessie L. Hansen
Jorge V. Jose
*Paul M. Kalaghan
Maurice Kaufman
Frank F. Lee
*Paul M. Lepley
*Juanita O. Long
*Harold Lurie
Bertram J. Malenka
Robert A. Millen
Stuart S. Peterfreund
Harlan D. Pratt
*Paul M. Platt
Donald J. Reaves
*Norman Rosenblatt
*Gerald E. Schumacher
Wallace W. Sherwood
Marilyn M. Smith
Michael R. Vaughn
Nancy Walden
Robert N. Weiner
John Zotos

* Appointed by the President

ORGANIZATION OF THE GRADUATE SCHOOLS

Administration

Linda J. Allen, M.Ed., Registrar of the Graduate Schools

Maryann G. Billington, M.B.A., Assistant Dean and Director of the Graduate School of Business Administration

Geoffrey Crofts, B. Comm., Dean of the Graduate School of Actuarial Science

Theodore N. Ferdinand, Ph.D., Director of the Graduate Program in Criminal Justice

Joseph M. Golemme, M.A., Director of the Graduate School of Professional Accounting

Deborah J. Hartry, M.Ed., Assistant Director of the Graduate School of Arts and Sciences and Assistant Dean of the College of Arts and Sciences

Thomas J. Kerr, M.S.I.E., Acting Director of the Graduate School of Engineering

John C. Monks, J.D., Associate Dean of the School of Law

J. Edward Neighbor, Ph.D., Director of the Graduate School of Arts and Sciences and Associate Dean of the College of Arts and Sciences

John L. Neumeyer, Ph.D., Director of the Graduate School of Pharmacy and Allied Health Professions

Catherine H. Roach, B.A., Associate Registrar of the Graduate Schools

Janice Walker, A.B., Assistant Dean and Director of the Graduate School of Boston-Bouvé College of Human Development Professions

Karl Weiss, Ph.D., Vice Provost for Research and Graduate Studies

The Graduate Council

The Council determines broad policies and regulations governing the conduct of graduate work. All new graduate programs must be approved by the Council.

Officers

Karl Weiss, Chairman
Alfred Viola, Vice Chairman
M. Patricia Hinds, Secretary

Executive Committee

Alfred Viola, Chairman
Edith E. Flynn, Vice Chairwoman
Joseph E. Barbeau (pro tem)
David N. Brown
Colleen C. Pantalone
Joseph J. Zelinski

Elected Faculty Members

Reginald L. Amory
Petros N. Argyres
Joseph C. Aurelia
Joseph E. Barbeau, Director, Boston-Bouvé College of Human Development Professions
Maryann Billington, Director, College of Business Administration
Norman R. Boisse
David R. Brown
Conrad Caligaris
Bohumil Cenkl
Charles J. Collazzo
Romine R. Deming
Richard C. Deth
Angelo J. Fiumara
Edith E. Flynn
Thomas N. Ferdinand, Director, College of Criminal Justice
Janice L. Foster
Robert R. J. Gallati
W. Jay Gillespie
M. Patricia Golden
Bernard M. Goodwin
Peter J. Graham, Jr.
Thomas F. Henstock
Steward V. Hoover
Thomas J. Kerr, Acting Director, College of Engineering
Bruce M. Logan
James A. Lomastro
Harry A. Mackay
Roger Millen
J. Edward Neighbor, Director, College of Arts and Sciences
John L. Neumeyer, Director, College of Pharmacy and Allied Health Professions
Irene A. Nichols
Colleen C. Pantalone
Sandra M. Parker
John D. Post
William G. Quill
Ernest Ruber
Martin Schetzen
Fred N. Schneiweiss
Alfred Viola
Joseph Westlund
Joseph J. Zelinski

Administrative Committee for Graduate and Professional Programs

Karl Weiss, Chairman
M. Patricia Hinds, Secretary
Linda D. Allen
Joseph E. Barbeau
Maryann G. Billington
Theodore N. Ferdinand
Joseph M. Golemme
Deborah J. Hartry
Thomas J. Kerr
Kathryn Luttgens
John C. Monks
Thomas E. Moore
J. Edward Neighbor
John L. Neumeyer

Committee of the Graduate School of Arts and Sciences
1982–83

Bohumil Cenkl, *Professor of Mathematics*
Francis Crisley, *Professor of Biology*
Geoffrey Davies, *Professor of Chemistry*
Karen H. Geelen, *Assistant Professor of Psychology*
M. Patricia Golden, *Associate Professor of Sociology*
Daryl A. Hellman, *Professor of Economics*
Harry MacKay, *Associate Professor of Psychology*
Eileen McDonagh, *Assistant Professor of Political Science*
John D. Post, *Professor of History*
Stewart Reiser, *Assistant Professor of Political Science*
Ernest Ruber, *Professor of Biology*
Michael T. Vaughn, *Professor of Physics*
Joseph E. Westlund, *Associate Professor of English*

index

A

Academic calendar, 5
Address of University, 1
Administration
  University, 181
  Graduate, 184
Admission (see also Courses), 20
  Doctor's degree, 24
  Master's degree, 23
Application, 19
Assistantships, 31

B

Biology, 34
  Courses, 39
  Faculty, 34
  Programs, 34
Board of Trustees, 180
Buildings, 15

C

Calendar, 5
Campus description and location, 9
  Map, 4
Center for Continuing Education, 10
Chemistry, 48
  Courses, 53
  Faculty, 48
  Programs, 49
Clinical Chemistry, 57
  Program, 58
  Courses, 60
Class hours, 22
Committee of the Graduate School of Arts and Sciences, 186
Cooperative Plan of Education, 9
  (see also Courses)
Corporation, 177
Courses
  Anthropology (see Sociology)
  Biology, 39
  Chemistry, 53
    Clinical Chemistry, 60
    Forensic Chemistry, 64
  Economics, 72
  English, 85
  History, 95
  Mathematics, 114
  Physics, 128
  Political Science, 135
  Psychology, 153
  Sociology, 167
Credits, 22

D

Degree programs, 23
  (see also Courses)
Doctor of Philosophy degree
  Admission, 25
  Comprehensive examination, 25
  Course requirements, 25
  Dissertation, 25
  Final oral examination, 26
  Interdisciplinary programs, 26
  Language requirement, 26
  Qualifying examination, 25
  Registration, 26
  Residence requirement, 25
  Time limitation, 26
  Transfer credit, 26

E

Economics, 66
  Courses, 72
  Faculty, 66
  Programs, 66
English, 79
  Courses, 85
  Faculty, 79
  Programs, 79
Evening programs (see Courses)

F

Fees, 28
Fields of Study (see Courses)
Financial aid, 29
Forensic Chemistry, 62
  Courses, 64
  Program, 62

G

Grading system, 22
Graduate School of Arts and Sciences, 19
  Fields of study, 33
  Registration, 5, 21
  Regulations, 19

H

History, 93
  Courses, 95
  Faculty, 93
  Programs, 93

I

Interdisciplinary programs, 26

L

Law, Policy, and Society, 102
- Courses, 105
- Program, 102

Library, 15
Loan program, 30

M

Map of campus, 4
Marine Science and Maritime Studies Center, 16
Mathematics, 110
- Courses, 114
- Faculty, 110
- Programs, 111

Master's degree (see also Courses)
- Admission, 23
- Comprehensive examination, 24
- Language requirement, 24
- Thesis, 24
- Time limitation, 24
- Transfer credit, 24

P

Part-time programs (see Courses)
Physics, 122
- Courses, 128
- Faculty, 122
- Programs, 124

Political Science, 133
- Courses, 135
- Faculty, 133
- Programs, 134

Programs of study, 21 (see Courses)
Psychology, 150
- Courses, 153
- Faculty, 150
- Programs, 151

R

Registration, 21
Regulations
- For doctor's degree, 24
- For master's degree, 23
- General, 19

Research, 10
Residence requirement, 21, 25

S

Sociology and Anthropology, 158
- Courses, 167
- Faculty, 158
- Programs, 158

Suburban campus, 11

T

Transfer Credit, 24
Tuition, 28

U

University Graduate Council, 185

W

Withdrawals, 23

Northeastern University Publishing Group
September 1982

Graduate School of Engineering Northeastern University 1982–84

409 Churchill Hall
360 Huntington Avenue
Boston, Massachusetts 02115
Telephone (617) 437-2711

Delivery of Services

The University assumes no liability, and hereby expressly negates the same, for failure to provide or delay in providing educational or related services or facilities or for any other failure or delay in performance arising out of or due to causes beyond the reasonable control of the University, which causes include, without limitation, power failure, fire, strikes by University employees or others, damage by the elements and acts of public authorities. The University will, however, exert reasonable efforts, when in its judgment it is appropriate to do so, to provide comparable or substantially equivalent services, facilities or performance, but its inability or failure to do so shall not subject it to liability.

The Northeastern University catalog contains *current information* regarding the University calendar, admissions, degree requirements, fees, and regulations, and such information is not intended to be and should not be relied upon as a statement of the University's contractual undertakings.

Northeastern University reserves the right in its sole judgment to promulgate and change rules and regulations and to make changes of any nature in its program, calendar, admissions policies, procedures and standards, degree requirements, fees, and academic schedule whenever it is deemed necessary or desirable, including, without limitation, changes in course content, the rescheduling of classes, cancelling of scheduled classes and other academic activities and requiring or affording alternatives for scheduled classes or other academic activities, in any such case giving such notice as is reasonably practicable under the circumstances.

We at Northeastern will do our best to make available to you the finest education we can provide, the most stimulating atmosphere in which to learn, and the most congenial conditions under which you may enjoy the learning experience. But the quality and the rate of progress of your academic career is in large measure dependent upon your own abilities, commitment, and effort. You will be a full participant in an educational partnership. We will and, indeed, can only make the opportunities available to you; it is up to you to take advantage of them.

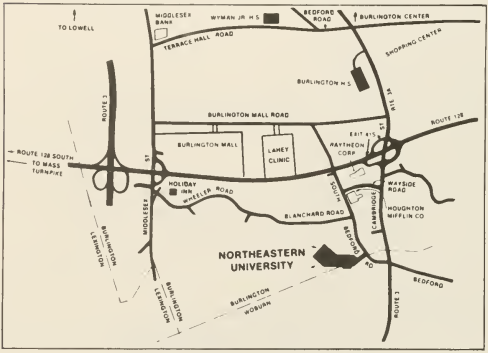
This is equally true with your career upon graduation. We cannot guarantee that you will obtain any particular job; that will depend upon your own skills, achievement, presentation, and other factors such as market conditions at that time. Similarly, in many professions and occupations there are increasing requirements imposed by federal and state statutes and regulatory agencies for certification or entry into a particular field. These may change during the period of time when you are at Northeastern and they may vary from state to state. While we will be ready to help you find out about these requirements and changes, it is your responsibility to initiate the inquiry because we cannot know what your expectations and understandings are unless you tell us.

In brief, what we are saying to you is that we are here to offer you educational opportunities and choices and to assist you in finding the direction in which you want to steer your educational experience. But you are a partner in this venture with an obligation and responsibility to yourself.

contents

Page

4 **Campus Maps**
5 **Academic Calendar**
6 **University Holidays**
9 **The University**
14 **Buildings and Facilities**
17 **Regulations of the Graduate School of Engineering**
18 General Regulations
23 The Master's Degree
26 The Doctor of Philosophy Degree
28 The Doctor of Engineering Degree
31 Interdisciplinary Programs
32 The Engineer Degree
35 **Financial Information**
35 Financial Obligations
36 Financial Aid
40 **Faculty**
44 **Fields of Study**
44 Civil Engineering
56 Mechanical Engineering
63 Electrical Engineering
75 Chemical Engineering
82 Industrial Engineering, Engineering Management, and Information Systems
94 Graduate Program in Transportation (Interdisciplinary)
97 **Description of Courses**
97 Civil Engineering
109 Mechanical Engineering
120 Electrical Engineering
141 Chemical Engineering
147 Industrial Engineering, Engineering Management, and Information Systems
159 Interdisciplinary Courses
159 Mathematics and Physics
160 **The Governing Boards and Officers of the University**
160 The Northeastern University Corporation
163 Board of Trustees
164 Administration Organization
166 General University Committees
167 Organization of the Graduate Schools
169 Committee on Graduate Study in Engineering
171 **Index**



Suburban Campus and Burlington High School

ACADEMIC CALENDAR 1982–83

Fall Quarter 1982

Registration period		
Burlington	Sept. 14–15	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	Sept. 20–23	1:00–8:00 p.m.
Classes begin	Sept. 27	
Last day to drop a course	Oct. 29	
Examination period	Dec. 13–18	

Winter Quarter 1982–83

Registration period		
Burlington	Nov. 30	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	Dec. 6–9	1:00–3:00 p.m., 5:30–8:00 p.m.
Classes begin	Jan. 3	
Last day to drop a course	Feb. 4	
Examination period	March 21–26	

Spring Quarter 1983

Registration period		
Burlington	March 8	1:00–3:00 p.m., 5:30–8:00 p.m.
Boston	March 14–17	1:00–3:00 p.m., 5:30–8:00 p.m.
Classes begin	April 4	
Last day to file card for Spring Commencement	May 15	
Last day to pay fee for Spring Commencement	May 20	
Last day to drop a course	May 6	
Examination period	June 13–18	
Spring Commencement	June 19	

Summer Quarter 1983

Registration period		
Burlington	June 13–14	5:30–8:00 p.m.
Boston	June 15–16	5:30–8:00 p.m.
Classes begin	June 27	
Last day to file card for Fall Commencement	Aug. 15	
Last day to pay fee for Fall Commencement	Aug. 29	

NOTE: For 1984 calendar, contact Registrar's Office, 120 Hayden Hall, 437-2181.

Calendar changes may be made. The University Community will be notified if such changes are necessary.

UNIVERSITY HOLIDAYS 1982–83

Columbus Day	Monday	October 11
Veterans Day	Thursday	November 11
Thanksgiving Recess	Thursday—Saturday	November 25–28
Christmas Vacation	Monday—Saturday	Dec. 20–Jan. 2
Martin Luther King, Jr., Day	Saturday	January 15
Washington's Birthday	Monday	February 21
Patriots' Day	Monday	April 19
Memorial Day	Monday	May 24
Independence Day	Monday	July 4
Labor Day	Monday	September 6

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admissions, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination.

Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age, national origin, or on the basis of being a handicapped but otherwise qualified individual. In addition, Northeastern takes affirmative action in the recruitment of students and employees. Further, Northeastern will not condone any form of sexual harassment.

Inquiries concerning our equal opportunity policies may be referred to the University Title IX Coordinator/Compliance Officer for Section 504 of the Rehabilitation Act of 1973, Affirmative Action Office, 175 Richards Hall, 617-437-2133 or -2139. Northeastern's efforts to comply with the Title IX Educational Amendments of 1972 are also coordinated by the Dean and Director of Affirmative Action, 175 Richards Hall.

Family Educational Rights and Privacy Act

In accordance with the Family Educational Rights and Privacy Act of 1974, Northeastern University permits its students to inspect their records wherever appropriate and to challenge specific parts of them when they feel it necessary to do so. Specific details of the law as it applies to Northeastern are printed in the *Student Handbook* and are distributed annually at registrations of University College and the graduate schools.

Emergency Closing of the University

Northeastern University has made arrangements to notify students, faculty, and staff by radio when it becomes necessary to cancel classes because of extremely inclement weather. Radio stations WBZ, WBCN, WEEI, WRBB, WHDH, WHUE, WJDA, WCOZ, WRKO, WLYN, WKOX, WVBF, WHAV, and WLLH will announce the University's decision to close.

The Office of Services for the Handicapped

The Office of Services for the Handicapped (OSH) provides a variety of support services and general assistance to all of Northeastern's disabled students and employees. The University's efforts to comply with the Rehabilitation Act of 1973 are coordinated by Ruth Bork, OSH Director, 5 Ell Center, 617-437-2675.

Fee Disclaimer

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and Board of Trustees at any time.

the university

Founded in 1898, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these in distinctive and serviceable ways. The University has not attempted to duplicate the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Education Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922); Arts and Sciences (1935); Education (1953); Pharmacy (1962); Nursing (1964); Boston-Bouvé College (1964); the College of Criminal Justice (1967); and by Lincoln College's daytime Bachelor of Engineering Technology program (1971). This educational method offers students the opportunity to gain valuable practical experience as an integral part of their college program and often provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses — offered by the University since 1906 — and adult day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas. All formal courses of study leading to degrees through part-time programs are approved by the Basic College faculties concerned.

GRADUATE AND PROFESSIONAL SCHOOLS

The eight graduate and professional schools of the University offer day and evening programs leading to the degrees listed.

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy. A program leading to the Certificate of Advanced Graduate Study in the field of Library Study is also available.

The Graduate School of Boston-Bouvé College of Human Development Professions offers the degrees of Master of Science, Master of Education, Doctor of Education, and the Certificate of Advanced Graduate Study.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate Program in Criminal Justice offers the degree of Master of Science.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science, Doctor of Philosophy, and Doctor of Pharmacy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education, located in Waltham, Massachusetts, serves the educational needs of the community through workshops, conferences, special programs, and public offerings. Programs include State-of-the-Art Engineering, Supervisory Management, Emergency Medical Technician, Paramedic, Graphic Arts, Food Industry, Paralegal, and many other specialized areas of interest. The Center awards nationally recognized Continuing Education Units (CEUs) to students who satisfactorily complete the programs. For further information about the Center's programs, telephone 617-890-1134.

RESEARCH

Northeastern University recognizes the importance of high quality research as an essential ingredient of academic life. The University's maturing focus on research takes into account not only the intrinsic value of specific research projects, but it also acknowledges the importance of research as a vital and integral part of graduate education.

Responsibility for fostering and coordinating the development of research at Northeastern resides with the vice provost for Research and Graduate Studies. Assisting him is the University Council on Research and Scholarship, which serves as an advisory body for dealing with broad policy issues as well as with procedures for encouraging and facilitating research and scholarship. The administrative support for research projects and training programs is provided by the Office of Sponsored Programs, whose services include the preparation and transmittal of proposals and reports, the monitoring of contracts and grant funds, and assistance in locating sources of support. A recently introduced newsletter entitled *Re:Search* brings information about the research and scholarly efforts of Northeastern's faculty and students to the University community and the general public.

Faculty and graduate students receive funding for their research from a variety of sources including government agencies, private industry, and foundations.

The National Institutes of Health, National Science Foundation, the National Endowment for the Humanities, IBM, Dow Chemical, and the Mellon Foundation are but a few of the organizations providing support. The University also contributes to many research projects through its own Research and Scholarship Development Fund. The fund was established to stimulate new ventures in research and scholarship and to provide seed money for the exploration of new ideas and approaches to problems which are likely to lead to high quality publications and extramural support.

Northeastern University has numerous distinguished faculty members, many of whom have received prestigious awards, including Sloan Scholarships, Guggenheim Fellowships, and National Institutes of Health Research Awards. Faculty members lecture the world over. Additionally, many faculty members serve as United States government consultants and participate on a variety of national and international committees.

Current research activities span almost every academic field and include laboratory projects, theoretical studies, and technological applications. Research is underway in the areas of business, physical and biological sciences, social sciences, humanities, allied health professions, and engineering. Student participation in these activities can take place as part of regular academic programs in the form of specially-designed independent studies, or through cooperative work assignments. Research involvement is actively encouraged and is limited only by the student's own motivation and curiosity.

The following summary of research represents just a small sample of the multitude of projects now underway throughout the University.

In the College of Arts and Sciences, research projects reflect the diversity of its nineteen departments. Research in the humanities and natural and social sciences includes studies in nineteenth century Boston architecture, the Off-Off Broadway theater, cable TV, quantum field theory, and infrared spectroscopy.

As part of the College's interdisciplinary interest in marine sciences, the Marine Science and Maritime Studies Center has been established. At the Nahant field station and laboratory of this Center, faculty and graduate students perform studies in marine chemistry, biology, and botany.

The nature of research in Boston-Bouvé College of Human Development Professions is broad in range and diverse in approach. Changes in human development and the roles of the teacher and clinician in facilitating such changes are topics of lively interest. Some of the current research interests of the College include the communication abilities in normal and hearing-impaired individuals, the role of exercise in cardiovascular health and disease, the relationship between age change and the development of motor and cognitive skills in children, the evaluation of clinical practice in physical therapy, and educational practices in the schools, and the examination of barriers to the employment of the disabled in leisure services.

Research in the College of Business Administration is divided between the theoretical and practical aspects of management, human resources, and marketing. New ideas in corporate practice and theory are conceived through in-

vestigations that include high technology, small business entrepreneurship, and foreign investment in developing countries. Other studies cover U.S. transportation problems, federal regulatory agencies, and technology forecasting for emerging high technology firms.

The College of Criminal Justice is one of the few institutions in the United States where crime and law are studied from interdisciplinary viewpoints. The focus of research in this College is on crime detection and prevention, industrial espionage, private security systems, and contemporary terrorism.

Research in the College of Engineering encompasses some of today's most important technological issues. Robotics, CAD/CAM, telecommunications, and space rocketry design are some of the areas under investigation. The College maintains close ties with industry, thereby augmenting its facilities and professional expertise. Other research activities deal with environmental, health, and transportation concerns.

The School of Law's research topics include an historical look at the Securities and Exchange Commission and studies of the new civil procedures. One project deals with the effects of the landmark *Tarasoff* court case on the mental health profession. National law school curricula policies are also under investigation.

The College of Nursing is addressing some of the important problems currently facing the entire nursing profession. An answer to nursing burnout is sought in the College's new school nurse practitioner program. Assessments of this new direction in nursing, and other employment possibilities and problems, are areas in which the faculty are directing their research efforts.

Research studies in the College of Pharmacy and Allied Health Professions include topics such as new analytical methods for antidepressant and anticonvulsant drugs, the synthesis of new drugs, improving diagnostic techniques for cancer of the bladder, and the study of clinical applications in respiratory therapy.

The Cooperative Education Research Center is concerned with the social and educational impact of the cooperative education mode. Through statistical surveys, data on cooperative education are compiled. Conclusions reached at this Center have important implications for future college costs, career opportunities, and educational priorities.

Northeastern also has several interdisciplinary centers and institutes in which research spanning several disciplines is performed.

The Institute of Chemical Analysis, Applications, and Forensic Science carries out basic research in analytical chemistry and material science. The Institute is also concerned with applications of these fields in industry, environmental regulatory agencies, and law and police departments. It has an international reputation in the fields of chromatography, mass spectrometry, amorphous metals, and solar energy storage devices.

The center for Electron Microscopy provides advanced scientific equipment for the training of scientists and the performance of research into cellular and subcellular structures.

The Institute for the Interdisciplinary Study of Education serves as a center for the exchange of ideas on critical issues in education. The high technology industry, South African education, and community college programs for prisoners are topics of current research.

The Center for Applied Social Research is a nationally known center for studies dealing with current public and social policy issues. Projects are presently underway in the fields of criminal justice, public safety, mental health, social welfare, and education.

Northeastern University is accredited by the New England Association of Schools and Colleges, Inc., which accredits schools and colleges in the six New England states. Accreditation by the Association indicates that the institution has been carefully evaluated and found to meet standards agreed upon by qualified educators.

buildings and facilities

MAIN CAMPUS

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, the Boston Public Library, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 50 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Most are interconnected by underground passageways.

Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

Libraries

The University library system consists of the Dodge Library, which is the main library; the Suburban Campus Library at Burlington; the School of Law Library; and divisional libraries for Physics and Electrical Engineering, Chemistry and Biology, Mathematics and Psychology, Health Education, Physical Education, Recreation and Leisure Studies, and Physical Therapy. There are additional subject collections for the Center for Management Development at Andover, Massachusetts, and the Marine Science Institute in Nahant.

The library collections number 470,000 volumes supplemented by some 550,000 titles in microprint, microfilm, and microfiche forms. The collection includes, in addition, 3,876 periodical titles, 100,000 documents, and more than 5,000 sound recordings.

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. It contains four basketball courts, an athletic cage, and a women's gymnasium, as well as administrative offices for the Department of Athletics and for the Physical Education Department of Boston-Bouvé College of Human Development Professions.

The Barletta Natatorium houses a 105-foot swimming pool, a practice tank for the crew, handball and raquetball courts, and shower and dressing facilities.

Northeastern Arena

Two blocks and a right turn away from the main quadrangle on Northeastern University's campus is the oldest indoor ice hockey arena in the United States and one of the focal points for amateur athletics in the Boston area.

Today, the Arena is primarily devoted to hockey and collegiate sports, but has expanded its university athletic focus to include all men's basketball contests and many women's varsity contests.

With more than a million and a half dollars already invested in the Arena, the building is a jewel to the eye and a credit to the community. So long as Northeastern owns the Arena, it will continue to meet the needs of the surrounding community as a superior recreational facility.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, college library, community recreation laboratory, folk arts center, a darkroom, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the associate and bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Warren Center

The Warren Center is a practical laboratory for Boston-Bouvé College of Human Development Professions in outdoor education and conservation, in group practicum, and in camping administration, programming, and counseling. At this Center in Ashland, completed in 1967, there are tennis courts, field

hockey and lacrosse fields, waterfront for swimming and boating, overnight camp sites, fields and forests, heated cottages, the Hayden Lodge with a recreation hall, library, crafts shop, dining facilities, and conference accommodations.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is located 12 miles from the main campus.

Marine Science and Maritime Studies Center

The Marine Science and Maritime Studies Center at Nahant, Massachusetts, is a research and instructional facility primarily engaged in studies of marine biology and oceanography. The Institute is operated all year, and is located about 20 miles northeast of Boston. Many of the courses at this institute are applicable toward an advanced degree in biology or health science.

Dedham Campus

The Dedham Campus is Northeastern University's newest addition and is located on Route 135 just north of Route 128. The facility contains eleven classrooms, two executive case-study rooms, a dining area and a computer room. There is also a library and a number of seminar rooms.

regulations of the graduate school of engineering

The Master of Science degree may be earned in Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering, Engineering Management, and Information Systems. In addition, there are programs leading to the Doctor of Philosophy degree in Chemical Engineering, Civil Engineering, Electrical Engineering, and Mechanical Engineering. The Doctor of Engineering degree is offered in Chemical Engineering. The Engineer degree may be earned in Electrical Engineering, Mechanical Engineering, and Industrial Engineering.

Cooperative Programs

A unique feature of Northeastern's Graduate School of Engineering is the full-time Cooperative Education Plan. This program adopts the philosophy that a balanced exposure to theory and practice will provide students with a more meaningful education.

The program includes nine months of classroom study and twelve months of work experience in an industrial concern. The cooperative student has the opportunity to gain vital experience in a professional environment while also supplementing his tuition payments.

The University has a full-time experienced staff to assist the student in obtaining a cooperative work assignment. Though the university cannot guarantee Cooperative Education employment to any student, its record of successful placements has been excellent. The student may also wish to investigate employment opportunities on his own in order to facilitate final placement by the graduate coordinator.

Graduate Engineering Cooperative Program

The cooperative programs are offered on two schedules. Both programs require an eighteen-month commitment for completing degree requirements. The *alternating* cooperative program is sequenced so that the work periods are of three and six months duration and are interspersed with three-month periods of classroom study in which students carry a full-time academic load of twelve quarter hours.

Alternating Schedule

Fall	School
Winter	Work
Spring	School
Summer	Work
Fall	Work
Winter	School

In the *parallel* program of cooperative education, a student is on work assignment for approximately thirty hours per week. In addition, the student is required to carry an academic load of eight hours per quarter. Except for the student's first quarter, this combination of classroom study and work is followed in each quarter of the traditional academic year.

Parallel Schedule

Fall	School	
Winter	School	Work
Spring	School	Work
Summer		Work
Fall	School	Work
Winter	School	Work

Normally, the Cooperative Plan operates as shown above. Economic conditions, the military, citizenship, and other factors may cause a departure from the normal Plan.

Engineering Sponsorships

Another aspect of Cooperative Education is the Engineering Sponsorship Program. This program provides students with exposure to academic theory and industrial experience. The sponsoring Company, by employing the students during cooperative work quarters, provides a monthly salary for the two (2) year period plus a tuition stipend.

All students who are accepted as full-time cooperative students are considered for Engineering Sponsorships. Notification will be received prior to April 15th if a student has been chosen for a sponsorship. Those students not chosen are still eligible for placement under the Cooperative Plan of Education.

GENERAL REGULATIONS

The general regulations and minimum requirements for all graduate programs are established by the University Graduate Council. In some matters the committee of each graduate school is allowed discretion to establish regulations within limits defined by the council. The regulations and academic requirements which follow have been formulated in accordance with this general policy.

Application Procedures

All applicants for cooperative full-time or continuous full-time study at the master's level should address inquiries to their respective departments or to the Graduate School of Engineering. Application forms and reference blanks will be mailed to the applicant. This material, together with the $25 nonrefundable application fee, two transcripts, two letters of recommendation, the Graduate Record Examination scores when required, and the results of the Test of English as a Foreign Language (required of all applicants whose native language is not English), should be returned to the Graduate School of Engineering Office as soon after January 15th as possible. The Admissions Committee will notify applicants as soon as their material is complete.

All applicants for part-time study at the master's level should request an application from the Graduate School of Engineering Office. The completed application, the nonrefundable $25 application fee and an official transcript should be sent to the graduate school no later than two weeks prior to the registration period for the quarter in which applicants plan to begin their programs. The dates of the registration periods are announced in the catalog (see academic calendar) and in the circular issued each July. Applicants will be notified by mail regarding acceptance. Mailed applications will be accepted up to two weeks prior to the registration period for the quarter in which the applicant plans to begin the program.

If an applicant is unable to submit the application material by mail at least two weeks prior to the registration period, he should call the Graduate School Office to arrange for a personal interview to determine his qualifications for admission. The application, the nonrefundable $25 application fee and the official transcript may be submitted at the interview.

In some cases, the Graduate Record Examination may be required of applicants. The examination is administered by the Educational Testing Service, Box 955, Princeton, New Jersey, 08540. Applicants must make their own arrangements with the Educational Testing Service for the examination.

Test scores for Graduate Record Examinations and Test of English as a Foreign Language sent to the Graduate School of Engineering are retained for only one year from the date they were taken. If an applicant does not enroll in the quarter for which he was accepted, but delays his registration for a period of one year or more from the date that he originally took his examinations, he must repeat the examinations or resubmit the original test scores before he will be permitted to register.

Transcripts

Official transcripts of previous college training must be supplied with the mailed application if an admissions decision is to be rendered by return mail, or submitted at the personal interview. If this is not feasible, the official transcripts must be mailed to the Graduate School of Engineering as soon after the initial registration as possible. Students who have attended institutions outside of the United States should provide comparable certified documents.

Students failing to file the necessary transcripts within one academic quarter after acceptance will be withdrawn from the Graduate School of Engineering.

Admission

To be admitted for graduate work, an applicant must have obtained a Bachelor of Science degree in engineering or a closely related science from a recognized college or university with an acceptable quality of undergraduate work. His scholastic record, therefore, must show ability to pursue creditably a program of graduate study, and his undergraduate training must indicate breadth as well as adequate preparation in the field in which the applicant expects to do advanced work. Acceptance to the school is granted upon recommendation of the departmental graduate committee or its designate following a review of the application and supporting material. The recommendation is based upon promise of academic success and fulfillment of minimum criteria established by each department in the Graduate School of Engineering.

Students with an engineering or related science bachelor's degree, who are enrolled in another graduate school at Northeastern, may transfer to the Graduate School of Engineering. However, they must make application and file the necessary documents, the same as transfers from other colleges or universities. The submission of registration materials for engineering course work does not constitute enrollment in the Graduate School of Engineering.

Registration

Students must register within the dates and times listed on the school calendar. The place of registraton will be announced prior to each period.

Auditors are not permitted. All students attending any course in the Graduate School of Engineering must be officially registered by the Registrar and listed on the class roster. Informing the instructor of the intention to attend the course does not constitute official registration and will not be recognized by the Registrar or the Graduate School of Engineering.

Any student who has not officially registered through the Registrar's Office by the end of the fifth calendar week of a quarter will not have any grades posted to their record.

Residence

All work for advanced degrees must be completed at the University unless approval has been obtained from the director of the graduate school for work taken elsewhere. Students who are in residence and are using the facilities of the University must register for such work.

Programs of Study

The curricula of the degree programs are given under each departmental heading. The descriptions of courses offered by the several departments are given so that prospective students may obtain a view of the course coverage.

Preparation courses are indicated when necessary. Not all courses are offered every year, but the course offerings will be arranged in such a manner that students may make continuous progress toward the degree.

The Graduate School of Engineering issues a circular close to July 1st which gives the courses for the following academic year and the times at which they meet.

The number of students enrolled in each class will be limited to permit effective teaching at the graduate level. The University reserves the right to cancel, postpone, combine, or modify any course.

At the time of his first registration, each full-time student must develop, with the assistance of his faculty adviser, a complete program of study for the degree for which he is registered. All subsequent changes must be approved by his faculty adviser.

Part-time students will be expected to complete the required courses outlined by each department, after which the elective courses may be undertaken. The study load for such students is limited to a program of two courses (4 quarter hours) per quarter, unless special permission to carry a heavier load is given by the director of the graduate school.

Grading System

The performance of students in graduate courses will be recorded by the instructor by use of the following grades:

A (4.0) This grade is given to those students whose performance in the course has been of very high graduate caliber.

A– (3.667)

B+ (3.333)

B (3.0) This grade is given to those students whose performance in the course has been at a satisfactory level.

B– (2.667)

C+ (2.333)

C (2.0) This grade is given to those students whose performance in the course is not at the level expected in graduate work.

C– (1.667)

F (0) This grade is given to those students whose performance in the course is unacceptable.

Individual faculty members may choose not to use plus and minus designations. If they use whole letters only, they must announce this to the class at the beginning of the quarter.

In addition, the following letter designations are used:

I Incomplete
This grade is given to those students who fail to complete the work of the course, and this work must be completed within one calendar year.

W Withdrawal
This grade is given to those students who were still officially registered at the end of the fifth calendar week of a quarter and then officially withdrew from classes.

S Satisfactory without quality designation.

U Unsatisfactory without quality designation.

These grades are used for the first quarter of a two-quarter sequence in which the grade for the second quarter applies to both the first and second quarters of the sequence. The designations S and U may also be used for thesis and seminar work.

Prerequisite/Advanced Undergraduate Courses

Prerequisite courses and advanced undergraduate courses will not be given credit unless approved by an academic adviser. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. The maximum number of credits allowed is determined by each academic department; refer to regulations as specified under course descriptions for each department. All courses of an undergraduate or prerequisite level are indicated by an asterisk (*) and apply to the quarter hour restrictions of the academic department.

Incomplete Grades

The I grade will be changed to a letter grade upon removal of the deficiency which caused the grade of I to be reported. Deficiencies must be made up within the quarter following that for which the grade of I is received unless an extension of time is granted by the instructor. However, such extension of time may not exceed one calendar year.

Any student who wishes to make-up a final examination must obtain permission from the director of the graduate school by the second week of the quarter succeeding that in which the examination was missed. The make-up examination must be taken in that succeeding quarter unless circumstances warrant permission of the director to defer it to one of the next two quarters.

A student who has attained an inordinate number of incompletes or withdrawals may, at the discretion of the Committee on Graduate Study in Engineering be asked to withdraw for failure to show continuous progress toward the degree.

Class Hours and Credits

All credits are entered as quarter hours. A quarter hour of credit is equivalent to three fourths of a semester hour credit. All classes meet on a quarter basis. In the summer session, classes meet for two, six-week periods. The academic calendar in the front of this catalog should be consulted for the opening and closing dates of each academic quarter.

Continuity of Program

Students are expected to maintain continuous progress toward the degree. Any student who has not completed a course within one year must apply to the director for readmission.

Withdrawals

In order to withdraw from a course, a student must fill out an official withdrawal form obtained at the Registrar's Office or at the Suburban Campus Office. Withdrawals may be made through the ninth class meeting of the quarter. Students will be withdrawn as of the date on which they fill out the official withdrawal form. Ceasing to attend a class or notifying the instructor does not constitute an official withdrawal.

Requests for withdrawal from a course after the ninth class meeting of the quarter may be submitted to the Director of the Graduate School, and may be approved to avert unusual hardships on a student.

A grade of W will be given to a student who is still officially registered at the end of the fifth calendar week of a quarter.

Changes in Requirements

The continuing development of the graduate school forces frequent revision of curricula. In every new bulletin some improvements are indicated. When no hardship is imposed on the student because of changes, and when the facilities of the school permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he entered becomes the binding one.

Filing for the Degree

Each student who plans to graduate either in June or September must submit to the Graduate Registrar's Office a completed commencement data card prior to the deadline listed in the academic calendar for that commencement at which he expects to receive the degree. If the deadline for filing is not met there is no assurance that the degree will be awarded that year. The commencement data card is supplied with the registration materials or is available in the Graduate Registrar's Office.

THE MASTER'S DEGREE

Admission

Specific requirements for each degree program will be found in the appropriate paragraphs for each academic department in the Graduate School of Engineering. General Requirements are listed under *Application Procedures*.

Academic Classifications

Students initially entering the Graduate School are classified into one of three groups according to their admission qualifications.

Regular students are those who meet in full all admittance criteria based on the standards established by the Committee on Graduate Study in Engineering.

Provisional students are those whose records are above the minimum required for acceptance but do not qualify them for regular admission based on

the standards established. Therefore, provisional students must obtain a 3.00 average in their first 12 quarter hours of course work to continue in the graduate school and be reclassified as regular.

Special students are those who do not wish to pursue a master's degree program or who may already possess the master's degree. Special students with only the bachelor's degree must meet the same admission criteria as the regular or provisional student and will be limited to a maximum of 12 quarter hours of graduate credits.

Any student whose record is not satisfactory may be dropped from the program regardless of his classification.

Academic Requirements

A candidate for the master's degree must satisfactorily complete an approved program consisting of a minimum of 40 quarter hours of correlated work of graduate caliber and such other study as may be required by the department in which he is registered.

To qualify for the Master of Science degree from the Graduate School of Engineering each student must have an average grade accumulative of not less than 3.00 with no more than 12 credits below a B– in all courses undertaken at Northeastern University. The Committee on Graduate Study in Engineering allows eight quarter hours of credit to be taken, in addition to the stated degree requirements, to repeat failed required courses or to substitute for elective courses to obtain the required 3.00 average for completion of degree requirements. The number of I grades that a student may accrue will be limited.

Within the above limitations for extra or repeated courses, a required course for which a grade of F is received must be repeated with a grade of C– or better, and may be repeated only once. If a grade of F is received in an elective course, that course may be repeated once to obtain a grade of C– or better, or another elective course may be substituted for it. If a grade of C– is received in a required course, that course may be repeated once to obtain a better grade.

Comprehensive Examination

At the discretion of the department, a final written or oral comprehensive examination may be required. Such examinations will be given at least two weeks before the commencement at which the degree is expected.

Thesis

If a thesis is required in partial fulfillment of degree requirements, it must show independent work based in part upon original material, and must meet the approval of the departmental graduate committee.

The thesis must receive a grade of B or better to be accepted. The original bound copy of the thesis must be deposited in Dodge Library. Instructions for the preparation of the thesis may be obtained from the Graduate School of Engineering.

Transfer Credits

A maximum of 12 quarter hours of credit obtained at another institution may be accepted toward the master's degree provided that the credits transferred are in the candidate's field, consist of work taken at the graduate level for graduate credit, carry grades of B or better, have been earned at a recognized college or university, and have not been used toward any other degree. Students should petition the Graduate School of Engineering in writing for all transfer credit after they have completed 12 quarter hours of graduate engineering work at Northeastern University. Official transcripts and catalog course descriptions must accompany the transfer petition before it will be processed. Grades on transfer credits may not be used for the purpose of obtaining the academic average necessary for completion of the degree requirements.

Time Limitations

Course credits earned in the program of graduate study, or accepted by transfer, are valid for a maximum of seven academic years unless an extension is granted by the Committee on Graduate Study in Engineering.

Financial Aid

A complete description of financial aid available to graduate students can be found in a later section of this catalog.

Cooperative Programs

All the departments offer the Cooperative Education Plan. The Cooperative Education Program offers each participant the opportunity for a variety of learning experiences that directly complement classroom theory. To maintain Cooperative Education status, students on the parallel plan must register for 8 quarter hours of graduate course work per quarter. During quarters of school attendance, students on the alternating plan must carry a continuous full-time academic load.

Full-Time Program

All the departments offer a continuous full-time program in which the requirements for the master's degree can be completed in one academic year, while maintaining at least 12 quarter hours of graduate course work per quarter.

Part-Time Program

All departments offer part-time programs in which the admission requirements are the same as for full-time programs. However, the program is established in such a way that students may progress according to their abilities and the time available. Part-time students may register for a maximum of 4 quarter hours of graduate course work per quarter. The curricula of the part-time programs are specified by the departments.

An official transcript of prior college work must be submitted with an application by those who apply by mail, or at the personal interview for those who apply after the deadline for mailing. Mail applications will be accepted up to two weeks prior to the registration period for the quarter in which the applicant plans to enter the Graduate School.

Honorary Societies

Northeastern University has chapters of Tau Beta Pi, Sigma Xi, and Phi Kappa Phi. Graduate students are eligible for consideration for election to these societies in accordance with the admission requirements of each organization.

THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy degree is awarded to candidates who give evidence of high attainment and research ability in their major field. The degree requirements are administered by committees in charge of each degree program. These committees may be departmental graduate committees or the committee of the graduate school, depending upon the nature of the program. It is the responsibility of the chairman of the committee to certify to the Graduate School of Engineering the completion of each requirement for each candidate.

Admission

Each degree program has an established admission procedure for students starting their doctoral work at Northeastern University. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

Students taking advanced graduate work are classified as follows:

1. Doctoral Student
   Students in this classification have been admitted to a doctoral program.

2. Doctoral Degree Candidate
   Students in this classification are doctoral students who have completed 40 quarter hours of acceptable graduate work beyond the bachelor's degree and have passed the qualifying examination.

3. Special Students
   This classification is given to students taking advanced graduate work who are not enrolled for a master's degree, and who have not been admitted to a doctoral program.

Residence Requirement

Candidates for the Doctor of Philosophy degree must spend the equivalent of at least one academic year in residence at the University taking graduate

work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of the degree program. The material covered in the qualifying examination and the level of course work necessary to prepare for the examination are established by the committee for each program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate. The purpose of this examination is to test the knowledge and skills of the student in a particular area and his knowledge of recent research developments in his field.

Course Requirements

The minimum course requirements of 40 quarter hours constitute the work normally required for a master's degree. The course requirements beyond this are the doctoral course requirements and the amount of such work necessary in each doctoral program is specified by the committee in charge of the doctoral program.

Dissertation

Each doctoral student must complete a dissertation which embodies the results of extended research and makes an original contribution to the field. This work should give evidence of the candidate's ability to carry out independent investigation and interpret in a logical manner the results of the research. The method of approval of the dissertation is established by the committee in charge of the degree program. The original bound copy of the dissertation must be deposited in Dodge Library. Instructions for the preparation of the dissertation may be obtained from the Graduate School of Engineering.

Language Requirement

The foreign language requirement and how it is satisfied is established by the committee in charge of each degree program.

Final Oral Examination

The final oral examination will be taken after completion of all other requirements for the degree. This examination must be held at least two weeks before the commencement at which the degree is to be awarded.

The committee for the final oral examination for the doctoral degree is appointed by the committee in charge of the degree program, and the director of the graduate school is notified of the time of the examination.

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the dissertation. Other fields may be included if recommended by the examining committee.

Transfer Credit

If transfer credit for doctoral course work is desired, approval for such transfer credit must be given by the committee in charge of the degree program.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements. If a student wishes to obtain a time extension, he may, with the approval of the committee of his degree program, petition the Committee on Doctoral Degree Programs of the University Graduate Council for such extension.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program. Students must be registered for dissertation during the quarter in which they take the final oral examination.

THE DOCTOR OF ENGINEERING DEGREE

The Doctor of Engineering degree is awarded to candidates who give evidence of high attainment and ability in their major field. The degree requirements are administered by committees in charge of each degree program. These committees may be departmental graduate committees or the committee of the graduate school, depending upon the nature of the program. It is the responsibility of the chairman of the committee to certify to the Graduate School of Engineering the completion of each requirement for each candidate.

Admission

Each degree program has an established admisson procedure for students starting their doctoral work at Northeastern University. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

Students taking advanced graduate work are classified as follows:

1. Doctoral Student
   Students in this classification have been admitted to the doctoral program.

2. Doctoral Degree Candidate
   Students in this classification are doctoral students who have completed 40 quarter hours of acceptable graduate work beyond the bachelor's degree and have passed the qualifying examination.

3. Special Students
   This classification is given to students taking advanced graduate work who are not enrolled for a master's degree, and who have not been admitted to a doctoral program.

Residence Requirement

Candidates for the Doctor of Engineering degree must spend the equivalent of at least one academic year in residence at the University taking graduate work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying Examination

Students must pass a qualifying examination within time limits set by the committee of the degree program. The material covered in the qualifying examination and the level of course work necessary to prepare for the examination are established by the committee for each program.

Comprehensive Examination

Degree programs may require a comprehensive examination during the time in which a student is a degree candidate. The purpose of this examination is to test the knowledge and skills of the student in a particular area and his knowledge of recent research developments in this field.

Course Requirements

The minimum course requirements of 40 quarter hours constitute the work normally required for a master's degree. The course requirements beyond this are doctoral course requirements, and the amount of such work necessary in each doctoral program is specified by the committee in charge of the doctoral program.

Dissertation

The dissertation for the Doctor of Engineering degree is fundamentally different from that of the Doctor of Philosophy degree. In general, the latter focuses on contributions to new knowledge in the engineering sciences and is expected to demonstrate the student's competence as a researcher. The dissertation for the Doctor of Engineering degree focuses on creative engineering design and in-depth engineering studies. It may, and usually will, contain elements that involve research, but above all, it must demonstrate the student's ability to work creatively on engineering analysis and design problems such as those en-

countered in professional practice. The method of approval of the dissertation is established by the committee in charge of the degree program. The original bound copy of the dissertation must be deposited in Dodge Library. Instructions for the preparation of the dissertation may be obtained from the Graduate School of Engineering.

Language Requirement

There is no foreign language requirement, but, in lieu of such a requirement, the student must demonstrate proficiency in computer software techniques and an acceptable machine language.

Final Oral Examination

The final oral examination will be taken after completion of all other requirements for the degree. This examination must be held at least two weeks before the commencement at which the degree is to be awarded.

The committee for the final oral examination for the doctoral degree is appointed by the committee in charge of the degree program, and the director of the graduate school is notified of the time of the examination.

The final oral examination will be on the subject matter of the doctoral dissertation and significant developments in the field of the dissertation. Other fields may be included if recommended by the examining committee.

Transfer Credit

If transfer credit for doctoral course work is desired, approval for such transfer credit must be given by the committee in charge of the degree program.

Time Limitation

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements. If a student wishes to obtain a time extension, he may, with the approval of the committee of his degree program, petition the Committee on Doctoral Degree Programs or the University Graduate Council for such extension.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for doctoral work, registration must be continuous unless withdrawal is allowed by the committee in charge of the degree program. Students must be registered for dissertation during the quarter in which they take the final oral examination.

Professional Experience

The student is required to present evidence of at least one calendar year of experience in engineering practice at a suitable professional level. This ex-

perience must have been acquired after completion of a bachelor's degree in a branch of engineering. The committee in charge of each degree program specifies the details of the professional experience requirement.

INTERDISCIPLINARY PROGRAMS

Some graduate students may wish to pursue doctoral programs which involve substantial work in two or more departments. To meet this need, an interdisciplinary program may be established which corresponds in scope and depth to doctoral standards, but does not agree exactly with the individual departmental regulations. For such possibilities, the following plan is in operation:

Admission

Application for admission to interdisciplinary doctoral study consists of the submission of a carefully thought-out written proposal describing the areas of proposed study and research. The proposal may be a part of the initial application for admission to graduate study at Northeastern University, or it may be submitted by a student already enrolled. It may be directed to a doctoral degree-granting department or to the director of the graduate school, who directs it to the appropriate department. In either case, admission to interdisciplinary doctoral study requires favorable recommendation by the sponsoring doctoral degree-granting department and approval by authorized representatives of the graduate study committees of the departments appropriate to the disciplines covered by the applicant's proposal. The sponsoring department becomes the registration base of the student.

Formation of Interdisciplinary Committee

A student who has been accepted for interdisciplinary study must obtain the consent of an adviser who will direct his doctoral thesis. This adviser, who may or may not be a member of the registration department, will be chairman of the interdisciplinary committee for this student. A second member will be appointed from the registration department by its chairman. These two members will obtain one or more additional members or request the director of the graduate school to do so. At least two departments must be represented on the committee and a majority of the committee must come from doctoral degree-granting departments. The chairman of the registration department will notify the director of the graduate school of the membership of the committee as soon as arrangements are complete.

Duties of Interdisciplinary Committee

A member of the interdisciplinary committee who is also a member of the registration department will serve as the registration officer to approve the course registration for the student. A copy of the approved course registration must also be filed with the other committee members and with the graduate study committee of the registration department.

The interdisciplinary committee will be responsible for the administration of the qualifying examination, language examination, approval of the dissertation, and comprehensive examination. This committee must also certify to the registration department the completion of the requirements for the award of the doctoral degree.

The interdisciplinary committee must assure that the program of the student represents standards comparable to those of the registration department and that the program is not so broad that it has inadequate depth in any area.

The program of the student may be reviewed at any time by the director of the graduate school to determine whether objectives of the program are being met.

THE ENGINEER DEGREE

The degree of Engineer is intended for those who do not wish to make a commitment to post-master's degree graduate study that is as extensive as that required for one of the doctor's degrees. It is an intermediate degree, between master's and doctor's degrees. A student who has completed the Engineer degree is eligible to apply for admission to a doctor's degree program.

Admission

Each departmental Engineer degree program has its own admission procedure for students beginning the program. Normally a master's degree in engineering or related field is required. Initial contact should be with the chairman of the appropriate department.

Classification and Degree Candidacy

A student admitted to the Engineer degree program will be designated as a candidate for this degree.

Residence Requirement

Candidates for the Engineer degree must spend the equivalent of at least two academic quarters in residence at the University taking graduate work. The committee of each degree program specifies the method by which the residence requirement is satisfied.

Qualifying and Comprehensive Examinations

The committee for each Engineer degree program specifies its own examinations. Normally, no qualifying examination is required for candidacy and no comprehensive examination is required for completion, but individual departments offering the degree may require such examinations.

Course Requirements

The minimum course requirement will be 40 quarter hours beyond the master's degree, with no more than 10 quarter hours of credit out of the 40

allowed for work on the dissertation. A minimum of 20 quarter hours must be taken in the department in which the degree is offered. Specific course requirements for each Engineer degree program are determined by the departmental committee in charge of the program.

Dissertation

Each Engineer degree student must complete a dissertation which demonstrates a high level of competence in engineering research, development, or design. As a general guideline, the amount of effort normally expected will be the equivalent of about 10 quarter hours of graduate course work. The method of approval of the dissertation is established by the departmental committee in charge of the degree program. The original bound copy of the dissertation must be deposited in Dodge Library. Instructions for the preparation of the dissertation may be obtained from the Graduate School of Engineering.

Language Requirement

No foreign language is required for the Engineer degree.

Final Oral Examination

A final oral examination may be required by the departmental committee in charge of the Engineer degree program. The examination will normally consist of a defense of the dissertation.

Transfer of Credit

Approval for transfer of credit must be given by the departmental committee in charge of the degree program.

Time Limitation

After admisson to the program, a maximum of five years will be allowed for completion of the degree requirements. Extension of this time limit may be granted with the approval of the departmental committee in charge of the degree program.

Registration

All students must register for course work or dissertation as approved by their advisers or the departmental registration officer. After the first registration for this work, registration must be continuous unless withdrawal is allowed by the departmental committee in charge of the degree program.

A PLAY THERAPY FACIL
1981 COMMUNITY SERVICE PROJE
THE BOSTON CHILDREN'S SERVICE FOR
867 BOYLSTON ST. BOSTON MA
NORTHEASTERN UNIVERSITY
THE AMERICAN SOC
BASEMENT B.C.S.
PLAN TITLE
SCALE

financial information

FINANCIAL OBLIGATIONS

Tuition

Tuition rates and all fees are subject to revision by the President and the Board of Trustees at any time. However, any change in tuition and fees will become effective at the beginning of the school year which follows the one in which the change was announced.

The tuition rate for graduate students in the School of Engineering is $135 per quarter hour of credit. Doctoral candidates actively utilizing the resources of the University in their Doctor of Philosophy or Doctor of Engineering dissertation are charged an additional $600 per quarter. Those doctoral candidates registered for dissertation work to be performed off campus are charged $200 per quarter in addition to tuition. Degree candidates that are no longer full-time students yet still need to complete thesis or dissertation requirements will be charged a continuation fee. This will entitle the student to limited access of various University facilities and privileges.

Tuition statements are mailed to students by the Bursar's Office and are payable by cash or check to Northeastern University on or before the date specified.

Fees

A $25 nonrefundable application fee must accompany the application for admission to the Graduate School of Engineering. No applications will be processed until the fee has been received.

Upon notification of acceptance, all full-time applicants are required to pay a tuition deposit of $50. This deposit will be credited to the student's tuition, and it is not refundable for those who do not register.

Other fees include a charge of $50 for late payment of tuition and a commencement fee of $25 for all degree candidates, payable before commencement by the date listed in the academic calendar.

For full-time students there is a charge of $12.50 per quarter for the services available in the Student Center. The fee for teaching assistants and research fellows is $6.25 each quarter. All part-time students on the Huntington Avenue Campus are charged $.75 a quarter.

All full-time students pay a nonrefundable University Health Service fee of $220 each year. This fee will provide Blue Cross-Blue Shield coverage and entitle the students to the medical care furnished by the University Health Services.

All financial obligations to the University must be discharged by graduation.

Upon acceptance, graduate international students new to Northeastern University are required to pay a one-time fee of $100.

Refunds

Tuition refunds will be granted only on the basis of the date appearing on the official withdrawal form filed by the student. Nonattendance does not constitute official withdrawal. Questions regarding refunds should be discussed with the Bursar's Office.

Refunds will be granted in accordance with the following schedule:

Amount of Refund:

Official Withdrawal Filed Within:	Percentage of Tuition
First week of quarter	100
Second week of quarter	75
Third week of quarter	50
Fourth week of quarter	25

FINANCIAL AID

The Office of Financial Aid offers two types of Federal assistance to graduate students: the National Direct Student Loan and Work-Study. All awards are based on financial need. Aid granted from these programs sponsored by the Federal Government is dependent upon the amount of funds allocated to Northeastern University.

Northeastern University is a participant in the Graduate and Professional School Financial Aid Service (GAPSFAS). All applicants for financial aid must file a GAPSFAS form in order to be considered for financial aid. This form may be obtained from the financial aid officer at the institution which the student now attends or from the Northeastern University Office of Financial Aid. All sections of the GAPSFAS form must be completed and sent to the Graduate and Professional School Financial Aid Service, Box 2614, Princeton, New Jersey 08540. Applicants for financial aid must also file the Northeastern University Graduate School Financial Aid Application and the Financial Aid Transcript; both forms may be obtained from the Office of Financial Aid.

To meet the financial aid application deadline (April 15 for fall quarter) students may have to apply for financial aid before they have been offered admission into the Graduate School. Those students must notify the Office of Financial Aid of the date of their acceptance.

Only complete applications will be reviewed for financial aid. A complete application contains:

1. a notarized Graduate School Financial Aid Application.
2. a GAPSFAS Form from Princeton, containing both the student's and the parents' financial information.

3. a Financial Aid Transcript from every college or university the student has attended.
4. notification of the student's admission into the Graduate School.

The University does not award financial assistance to students who are not citizens or permanent residents of the United States.

National Direct Student Loan

This program is available to full-time graduate students who show a high level of financial need. Graduate students may borrow up to $12,000 during the course of their educational careers. Repayment and interest do not begin until six months after the student ceases to carry at least a half-time academic load. Repayment may be extended over a ten year period with an interest rate of five percent per annum. No payments are required for up to three years while a borrower is serving in the Armed Forces, Peace Corp, VISTA, or while working as a full-time volunteer for a tax-exempt charitable organization.

College Work-Study Program

This program is available to full-time graduate students who show financial need. It is designed to give students an opportunity to earn as much as $5.00 per hour working in jobs on or off campus in public or private nonprofit organizations. This program is administered solely by the Office of Financial Aid and should not be confused with the University's Cooperative Education Program.

Guaranteed Student Loan Program

Under this program, students whose families have adjusted gross incomes under $30,000 may borrow money for educational expenses from banks or other private lending institutions. Students whose families have adjusted gross incomes which exceed $30,000 may also borrow if they can show financial need in accordance with guidelines established by the U.S. Department of Education. Students must be enrolled on at least a half-time basis to be eligible for these loans. Terms and conditions of these loans vary from state to state. Repayment, which begins six months after the student ceases to carry at least a half-time load, may be extended for as long as ten years. The interest rate during repayment is nine percent per annum. No payments are required for up to three years while the borrower is serving in the Armed Forces, Peace Corps, VISTA, or while working as a full-time volunteer for a tax-exempt charitable organization. Information and applications are available from lenders, state guarantee agencies, and regional offices of the U.S. Department of Education. Massachusetts residents may contact the Office of Financial Aid for more information.

SCHOLARSHIPS

Northeastern University Fellowships (NUF)

These fellowships are to assist a limited number of students accepted for full-time study in the Graduate Schools of the University. The awards are made to students who demonstrate superior academic achievement and are competitive within each graduate school. Stipends cover tuition and fees. Applications may be obtained from the Graduate School Office.

Martin Luther King, Jr., Scholarship

A limited number of full-time Martin Luther King, Jr., Scholarships are available. These Scholarships pay the recipient's full tuition and fees during the course of satisfactory graduate work. Further information and applications are available at the African-American Institute, Northeastern University, 40 Leon Street, Boston, Massachusetts 02115.

Please Note: This information is current as of the date of publication. All federal programs are subject to change. Please check with the Office of Financial Aid to determine the status of Financial Aid programs at the time you plan to enroll.

ASSISTANTSHIPS

The Graduate School of Engineering has available the following types of assistantships and fellowships for support of graduate students. Those interested in financial aid must apply through the chairman of the major department. The chairmen or representatives of the Department are listed in the catalog under the Committee on Graduate Study in Engineering.

Appointments to fellowships and assistantships are ordinarily announced no later than April 15 for the following academic year or summer. Appointments are for a maximum of one year and are not automatically renewed. Students who hold assistantships and research fellowships are expected to devote full time to their studies and the duties of the grant. They may not accept outside employment without the consent of their faculty advisers and the director of the graduate school.

Teaching Assistantships

A limited number of teaching assistantships are available in all departments. Teaching assistantships offer graduate students the opportunity to receive a tuition scholarship (maximum tuition remission of 6 quarter hours per quarter). A stipend is also awarded with the assistantship to students who, in return, devote half time to academic assistance directly related to the teaching function. Students receiving such awards are expected to devote the balance of their time to course work.

Graduate Administrative Assistantships

Graduate Administrative Assistantships offer graduate students the opportunity to receive a tuition scholarship (maximum tuition remission of 6 quarter hours per quarter). A stipend is also awarded to students who, in return, devote half time to assisting the department in nonteaching, administrative duties.

Research Fellowships

A number of departments offer research fellowships, including N.I.H. and N.S.F., which provide students the opportunity to receive a tuition scholarship. A stipend is also awarded to students who, in return, do research in the department. Certain of these grants require half-time work on research in the department, with the remaining time devoted to course work. Others provide for full-time work on research used for thesis or dissertation.

Doctoral Research Fellowships

In the departments which give work leading to the Ph.D. degree, research fellowships may be available for students who have established candidacy for the Ph.D. degree.

Northeastern University Tuition Assistantship (NUTA)

A limited number of tuition assistantships are available offering remission of tuition to full-time students assisting ten hours a week in the administrative work of the department. These awards are normally given to students in the first year of graduate work. Students should note that the value of the tuition received via this type of assistantship is taxable. Applications may be obtained from the Graduate School Office.

Residence Hall Staff Positions

A limited number of residence staff positions in housing facilities are available each year. Appointments carry a minimum compensation of room and board. Further information may be obtained from the Office of University Housing, 104–106 Ell Building.

ACCEPTANCE CONDITIONS

Northeastern University, which is a member of the Council of Graduate Schools of the United States, subscribes to the following resolution of the Council:

Acceptance of an offer of financial aid (such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by an actual or prospective graduate student completes an agreement which both student and graduate school expect to honor. In those instances in which the student accepts the offer before April 15 and subsequently desires to withdraw, the student may submit in writing a resignation of the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment has been made. Similarly, an offer by an institution after April 15 is conditional on presentation by the student of the written release from any previously accepted offer.

faculty

George Adams, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Charles T. Ajamian, B.S., M.S., Ph.D., *Lecturer in Engineering*
Edward Alstshuler, B.S., M.S., Ph.D., *Lecturer in Engineering*
Reginald L. Amory, B.C.E., M.C.E., Ph.D., *Professor of Civil Engineering*
Paul C. Barr, B.E.E., *Lecturer in Engineering*
Geoffrey N. Berlin, B.S., M.S., Ph.D., *Assistant Professor of Industrial Engineering*
Frederick C. Blanc, B.S., M.S., Ph.D., *Professor of Civil Engineering*
Paul H. Blinco, B.S., M.S., Ph.D., *Lecturer in Civil Engineering*
Charles O. Bolthrunis, B.S., B.S., S.T.B., *Lecturer in Chemical Engineering*
H. Frederic Bowman, B.S., M.S., Nuc.E., Ph.D., *Associate Professor of Bio-Medical Engineering*
George H. Brattin, B.S., M.S., *Instructor of Civil Engineering*
Allan S. Bufferd, B.S., M.S., D. Sc., *Lecturer in Engineering*
Ralph A. Buonopane, B.S., M.S., Ph.D., *Associate Professor of Chemical Engineering*
Stanley T. Burak, B.S., *Lecturer in Engineering*
Michael J. Burke, B.S., M.S., M.B.A., *Lecturer in Civil Engineering*
Leroy M. Cahoon, B.S., M.S., *Associate Professor of Civil Engineering*
Marcello J. Carrabes, B.S., M.S., *Associate Professor of Electrical Engineering*
Richard I. Carter, B.S., M.S., *Associate Professor of Information Systems*
William Carter, B.S., M.S., *Lecturer in Engineering*
John H. Cashman, B.S., M.S., *Lecturer in Engineering*
Sam. P. Chaudhuri, B.E.E.E., M.E.E.E., Ph.D., *Lecturer in Engineering*
Stephen Ching, B.S., Ph.D., *Lecturer in Engineering*
John W. Cipolla, Jr., B.S., M.S., Ph.D., *Professor of Mechanical Engineering*
John J. Cochrane, B.S., M.S., Ph.D., *Professor of Civil Engineering*
Basil L. Cochrun, B.S., M.S., *Professor of Electrical Engineering*
Menashi D. Cohen, B.S., M.S., Ph.D., *Assistant Professor of Civil Engineering*
Jerome J. Connor, Jr., S.B., S.M., Sc.D., *William Lincoln Smith Professor and Chairman of the Civil Engineering Department*
Thomas Cullinane, B.S., M.S., *Associate Professor Industrial Engineering*
Cameron H. Daley, B.S., M.S., *Lecturer in Engineering*
Siben Dasgupta, B.S., M.S., *Lecturer in Engineering*
Foster J. DeGiacomo, B.S., *Lecturer in Engineering*
Anthony J. Devaney, B.S., M.S., Ph.D., *Lecturer in Engineering*
Joseph DiGiovanni, B.S., J.D., *Lecturer in Civil Engineering*
James G. Dolan, B.S., *Lecturer in Engineering*
Ladislav Dolansky, Ing., M.S., E.E., Ph.D., *Professor of Electrical Engineering*
Elisabeth M. Drake, S.B., Sc.D., *Cabot Corporation Professor and Chairperson of the Chemical Engineering Department*
Charles Drane, B.S., S.M., Ph.D., *Lecturer in Engineering*
John F. Dunn, Jr., S.B., S.M., Sc.D., *Professor of Mechanical Engineering*
James M. Feldman, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Melvin D. Field, B.S., S.M., Sc.D., *Lecturer in Engineering*
Samuel Fine, B.S., M.S., M.D., *Professor of Electrical Engineering and Chairman of Bio-Medical Engineering*
Arthur R. Foster, B.S., M.Engg., *Professor of Mechanical Engineering*
Clifford J. Fralen, B.S., M.S., *Lecturer in Engineering*
David R. Freeman, B.S., M.S., Ph.D., *Professor of Industrial Engineering*
Peter G. Furth, B.S., M.S., Ph.D., *Assistant Professor of Civil Engineering*

Maurice Gertel, B.S., M.S., *Lecturer in Engineering*
Lewis Geyer, B.S., M.S., Ph.D., *Professor of Industrial Engineering*
J. Duncan Glover, B.S., M.S., Ph.D., *Assistant Professor of Electrical Engineering*
Kenneth I. Golden, B.S., S.M., M.E., Ph.D., *George A. Snell Professor of Engineering*
David S. Goldman, B.S., M.S., *Lecturer in Engineering*
Robert A. Gonsalves, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Bernard M. Goodwin, B.S., Sc.D., *Associate Professor of Chemical Engineering*
Alexander M. Gorlov, Engineer, Ph.D., *Associate Professor of Mechanical Engineering*
Arvin Grabel, B.E.E., M.E.E., Sc.D., *Professor of Electrical Engineering*
Constantine J. Gregory, B.A., M.S., Ph.D., *Professor of Environmental Sciences*
Richard E. Grojean, B.S., M.S., *Associate Professor of Electrical Engineering*
David Gronewold, B.S., M.S., *Lecturer in Engineering*
Edward M. Gulachenski, B.S., M.S., *Lecturer in Engineering*
Surendra Gupta, B.E.E.E., M.S.I.E., M.B.A., Ph.D., *Associate Professor of Industrial Engineering and Information Systems*
Edgar B. Gutoff, B.Ch.E., S.M., Sc.D., *Lecturer in Chemical Engineering*
Peter K. Hadley, B.S., M.S., *Instructor of Civil Engineering*
Pamela Halpern, B.A., M.S., *Instructor in Information Systems*
Donald Harahy, B.S., M.S., *Lecturer in Engineering*
Robert L. Harvey, B.S., M.S., Ph.D., *Lecturer in Engineering*
David Heimann, B.S., M.S., *Lecturer in Engineering*
Stewart V. Hoover, B.S., M.S., Ph.D., *Associate Professor of Industrial Engineering*
Thomas C. Houston, B.S., M.U.A., M.S., *Lecturer in Civil Engineering*
Thomas E. Hulbert, B.M.E., M.S., *Associate Professor of Industrial Engineering*
Magdi T. IsHak, B.S., M.S., *Lecturer in Engineering*
Walter E. Jaworski, B.S., M.S., D.Sc., *Associate Professor of Civil Engineering*
Paul A. Kales, B.S., M.S., *Lecturer in Engineering*
Martin Kaliski, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Arthur Kantrowitz, B.S., M.S., Sc.D., *Adjunct Professor*
Israel Katz, B.S., M.ME., *Professor in Engineering Technology*
Wayne G. Kellner, B.S., S.M., Sc.D., *Associate Professor of Electrical Engineering*
Thomas J. Kerr, B.S., M.S., Ph.D., *Lecturer in Engineering*
McKeen Kessel, B.S., *Lecturer in Engineering*
Pamidipula Kotiveeriah, B.S., M.S., Ph.D., *Lecturer in Engineering*
Gregory J. Kowalski, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Michael Kupferman, B.S., M.S., Ph.D., *Associate Professor of Civil Engineering*
Robert J. Lechner, B.S., M.S., Ph.D., *Associate Professor in Electrical Engineering*
Kenneth M. Leet, B.S., M.S., D.Sc., *Professor of Civil Engineering*
Edward F. Levell, B.S., M.S., *Lecturer in Engineering*
Thomas Litrenta, B.S., M.S., Ph.D., *Lecturer in Engineering*
Walter H. Lob, B.S., M.S., *Associate Professor of Electrical Engineering*
Robert F. London, A.B., M.B.A., *Lecturer in Engineering*
Bertram S. Long, B.S., M.S., M.E., *Associate Professor of Mechanical Engineering*
Thomas J. Macdonald, B.S., M.S., *Lecturer in Engineering*
John D. Macey, B.S., M.S., *Lecturer in Engineering*
Robert N. Martin, B.S., M.S., *Associate Professor of Electrical Engineering*
David W. McDougall, B.S., M.S., *Lecturer in Civil Engineering*
William J. Meehan, B.S., M.E., *Lecturer in Engineering*
Herbert Meiselman, B.S., M.S., Ph.D., *Lecturer in Engineering*
Emanuel Melachrnoudis, B.S., M.S., Ph.D., *Assistant Professor in Industrial Engineering*
Robert L. Meserve, B.S., M.S., *Associate Professor of Civil Engineering*
Mohamad Metghalchi, B.S., M.S., ScD., *Assistant Professor of Mechanical Engineering*
Marvin M. Miller, B.S., M.A., Ph.D., *Lecturer in Engineering*
Ernest E. Mills, B.S., M.S., *Associate Professor of Mechanical Engineering and Mechanical Engineering Technology*
James D. Murphy, B.S., *Lecturer in Engineering*
Jeremiah Murphy, B.S., M.S., *Lecturer in Civil Engineering*

Paul J. Murphy, B.S., M.S., *Lecturer in Engineering*
Richard J. Murphy, B.S., M.S., Ph.D., *Professor of Mechanical Engineering*
Saul Namyet, S.B., *Associate Professor of Civil Engineering*
J. David Naparstek, A.B., Sc.M., *Lecturer in Civil Engineering*
Swami Narayanan, B.S., B. Tech., M. Tech., Ph.D., *Lecturer in Chemical Engineering*
Warren G. Nelson, S.B., S.M., Sc.D., *Associate Professor of Mechanical Engineering*
Robert A. Nery, B.S., *Lecturer in Engineering*
David W. Noones, B.S., M.S., *Lecturer in Engineering*
Welville B. Nowak, S.B., Ph.D., *Donald W. Smith Professor of Engineering*
James C. O'Shaughnessy, B.S., M.S., Ph.D., *Associate Professor of Civil Engineering*
Alan S. Parkes, B.A., Ph.D., *Lecturer in Engineering*
Hormoz Pazwash, B.S., M.S., Ph.D., *Associate Professor of Civil Engineering*
Syed Peeran, B.E., M.E., Ph.D., *Lecturer in Engineering*
Ronald F. Perry, B.S., M.S., Ph.D., *Associate Professor of Industrial Engineering*
Thomas E. Phalen Jr., B.S., M.S., *Associate Professor of Mechanical Engineering Technology*
Nathan Phillips, B.S., M.S., *Lecturer in Engineering*
William C. Pisano, B.C.E., M.S., S.M., Ph.D., *Lecturer in Civil Engineering*
Richard Platcow, B.S., M.S., *Lecturer in Engineering*
Stephen L. Priest, B.S., M.S., *Lecturer in Engineering*
John G. Proakis, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Harold R. Raemer, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Wilfred J. Remillard, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
George O. Reynolds, B.S., M.S., *Lecturer in Engineering*
William J. Roache, B.S., M.S., *Lecturer in Civil Engineering*
J. Spencer Rochefort, B.S., M.S., *Professor of Electrical Engineering and Chairman of the Department*
Michael Rudko, B.S., M.S., Ph.D., *Associate Professor of Electrical Engineering*
John N. Rossettos, B.S., M.S., Ph.D., *Professor of Mechanical Engineering*
Khalid Saeed, M.Eng., *Lecturer in Engineering*
Gerald D. Saks, B.M.E., M.B.A., *Lecturer in Engineering*
Sheldon S. Sandler, B.S., M.Eng., M.A., Ph.D., *Professor of Electrical Engineering*
Malukutla Sarma, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Gerhard O. Sauermann, B.S., M.S., Ph.D., *Lecturer in Engineering*
Martin Schetzen, B.E.E., S.M., Sc.D., *Professor of Electrical Engineering*
Mikkail Schiller, B.S., M.S., *Lecturer in Civil Engineering*
John K. Schindler, S.B., S.M., Ph.D., *Lecturer in Engineering*
John G. Schoon, M.S., Ph.D., *Associate Professor of Civil Engineering*
Walter C. Schwab, S.B., S.M., Ph.D., *Professor of Electrical Engineering*
Richard J. Scranton, B.S., M.S., *Associate Professor of Civil Engineering*
Mohammad Shishizaz, B.S., M.S., *Instructor in Mechanical Engineering*
Michael B. Silevitch, B.S., M.S., Ph.D., *Professor of Electrical Engineering*
Irwin Silverstein, B.S., M.S., *Instructor in Civil Engineering*
John M. Slepetz, B.CE., M.CE., Ph.D., *Lecturer in Engineering*
Barkev Siroonian, B.A., M.S.P.H., M.S., *Lecturer in Civil Engineering*
Charles A. Steele, Jr., A.B., A.M., M.S., M.A.Sc., *Lecturer in Engineering*
Richard R. Stewart, B.S., M.S., Ph.D., *Associate Professor of Chemical Engineering*
Christopher Stiehl, B.S., M.S., *Lecturer in Engineering*
Robert D. Stuart, M.A., Ph.D., *Professor of Electrical Engineering*
Robert L. Sullivan, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Lawrence Symington, B.S., M.S., Ph.D., *Lecturer in Engineering*
Ahmet Talug, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Barbara Baum Taylor, B.S., S.M., Ph.D., *Associate Professor of Civil Engineering*
Robert M. Torbin, B.S., M.S., *Lecturer in Civil Engineering*
Thomas Vasilos, B.S., Sc.D., *Lecturer in Engineering*
Anthony J. Venuti, B.S., M.B.A., *Lecturer in Engineering*
Steven J. Wallach, B.S., M.S., M.B.A., *Lecturer in Engineering*
Sidney Wartel, B.S., M.S., J.D., *Lecturer in Civil Engineering*
Irvine W. Wei, B.S., M.S., Ph.D., *Associate Professor of Civil Engineering*

Lin-Jyh Weng, B.S., M.S., Ph.D., *Lecturer in Engineering*
John A. Williams, B.S., M.S., Ph.D., *Professor of Chemical Engineering*
John L. Williams, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Bernie T. Woodrow, B.S., M.S., *Lecturer in Engineering*
Mishac K. Yegian, B.S., M.S., Ph.D., *Associate Professor of Civil Engineering*
Alvin J. Yorra, B.S., M.S., *Associate Professor of Mechanical Engineering*
Ibrahim Zeid, B.S., M.S., Ph.D., *Assistant Professor of Mechanical Engineering*
Joseph J. Zelinski, B.S., Ph.D., *Professor of Mechanical Engineering*
John Zotos, B.S., M.S., Met.E., *Associate Professor of Mechanical Engineering*

civil engineering

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Civil Engineering, applicants must have obtained a Bachelor of Science degree in Civil Engineering, with an acceptable quality of undergraduate work, from a recognized institution. Applicants with a Bachelor of Science degree from a recognized institution in some other engineering field or related science and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science.

THE MASTER'S DEGREE

General

The master's degree requirements can be completed on the Cooperative Plan, on a full-time basis or part-time in the evening. Forty quarter hours of academic work are required. A master's report carrying 4 q.h. of credit, or a thesis of 8 q.h. credit is required in all programs (environmental, structural, transportation, geotechnical, and construction).

A meaningful sequence of electives must be chosen which meets the approval of the department. Department interviews are necessary early in the program for all students in order than an approved program of electives may be arranged with the individual.

Full-Time Program on the Cooperative Plan

The full-time program on the Cooperative Plan may be pursued on either the alternating or parallel schedules. Both programs require a minimum of an eighteen-month commitment for completing degree requirements. Students who are admitted to a Masters Degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment to be eligible for the degree. Please refer to section describing the regulations of the graduate school for a more complete description of the cooperative education programs.

Continuous Full-Time Programs

Students may take academic work on a continuous full-time basis and complete degree requirements in one academic year. The sequence of courses which students take on this plan is established by their adviser.

Part-Time Programs

The admission requirements for these programs are similar to those for the full-time program, but students may progress according to their ability to com-

bine their study load with their employment load. A maximum of seven years is allowed to complete the program.

Substitutions

With the approval of the department, substitutions may be made for some of the prescribed courses by other courses in the department or in other departments which offer graduate work.

STRUCTURAL ENGINEERING

The Structural Engineering Program emphasizes basic courses in Structural Analysis, Design of Steel and Concrete Structures, Soil Mechanics, and Foundation Engineering. Advanced topics in Dynamics and Stability and Numerical Methods round out a comprehensive presentation which may be supplemented by offerings from other programs, such as mechanical engineering or industrial engineering. Courses in Probability and Systems Analysis are also available from other Civil Engineering programs.

SPECIMEN FULL-TIME PROGRAM

Fall Quarter		Credits
1.847	Advanced Structural Mechanics (Days)	4
1.853	Concrete Structures I	2
1.861	Design of Structures I	2
1.871	Soil Mechanics I	2
1.882	Engineering Geology ('83–'84 academic year)	2
1.886	Soil Dynamics I	2
	(Minimum)	14

Winter Quarter		Credits
1.854	Concrete Structures II	2
1.862	Design of Structures II	2
1.872	Soil Mechanics II	2
1.887	Soil Dynamics II	2
1.890	Numerical Methods in Civil Engineering (Days)	4
1.993	Master's Report	4
	or	
1.991	Thesis	8
	(Minimum)	14

Spring Quarter		Credits
1.850	Seismic Design	2
1.851	Selected Topics in Earthquake Engineering ('82–83 Academic Year)	2
1.855	Concrete Structures III	2

1.859	Stability ('83–'84 academic year)	2
1.863	Design of Structures III	2
1.878	Foundation Engineering (Days)	4
	(Minimum)	12

PART-TIME PROGRAM

Required Courses		Credits
1.993	Master's Report	4
	or	
1.991	Thesis	8
	(Minimum)	4

Electives (Part-time Program)

Students in the Structural Engineering major must elect 30 quarter hours from civil engineering courses within the structural engineering field.

Six quarter hours may be elected from any courses in engineering or science for which the student has the necessary preparation.

The electives will normally be available according to the following schedule:

Fall Quarter		Credits
1.841	Advanced Structural Mechanics I	2
1.853	Concrete Structures I	2
1.861	Design of Structures I	2
1.871	Engineering Properties of Soils I	2
1.874	Foundation Engineering I ('82–'83 academic year)	2
1.882	Engineering Geology ('83–'84 academic year)	2
1.886	Soil Dynamics I	2
1.888	Numerical Methods in Civil Engineering I	2

Winter Quarter		Credits
1.842	Advanced Structural Mechanics II	2
1.854	Concrete Structures II	2
1.862	Design of Structures II	2
1.872	Engineering Properties of Soils II	2
1.875	Foundation Engineering II ('82–'83 academic year)	2
1.884	Rock Mechanics I ('83–'84 academic year)	2
1.887	Soil Dynamics II	2
1.889	Numerical Methods in Civil Engineering II	2

Spring Quarter		Credits
1.843	Finite Element Analysis of Structures I	2
1.849	Model Analysis	2

1.850	Seismic Design	2
1.851	Selected Topics in Earthquake Engineering ('82–'83 academic year)	2
1.855	Concrete Structures III	2
1.859	Stability ('83–'84 academic year)	2
1.863	Design of Structures III	2
1.876	Foundation Engineering III ('82–'83 academic year)	2
1.885	Rock Mechanics II ('83–'84 academic year)	2

TRANSPORTATION ENGINEERING

The Transportation Engineering Program is designed for students with career goals in transportation engineering, planning, or research. This program may consist of courses from engineering, liberal arts, and business. A minimum of 40 credit hours is required for a graduate degree and may be obtained on a part-time or full-time schedule.

A Master of Science in Civil Engineering degree will be awarded to students who have an accredited undergraduate degree in civil engineering and have completed at least 24 credit hours in civil engineering courses, i.e. courses designated with 01.– numbers. A Master of Science degree will be awarded to qualifying students who do not have an undergraduate degree in civil engineering or who do not meet the minimum 24 credit hour requirement in civil engineering courses. A student may elect to take nontechnical electives in arts and sciences and business administration. A maximum of nine credit hours in nontechnical fields will be allowed.

A typical program of study would normally consist of courses shown in the specimen program. Substitution for the courses listed in the specimen program may be made depending on the student's interests, academic background and career objectives. Each student is expected to consult with his faculty adviser to develop an approved program of study.

For a complete listing of courses and course descriptions, consult appropriate sections of the graduate school catalogues for Engineering, Arts and Sciences, and Business Administration. Further information can be obtained within this catalogue under *Graduate Program in Transportation,* which describes the interdisciplinary program in transportation leading to a Master of Science in Transportation degree.

SPECIMEN PROGRAM

Required Courses		Credits
1.807	Systems Analysis I	2
1.808	Systems Analysis II	2
1.813	Traffic Flow Theory I	2
1.814	Traffic Flow Theory II	2
1.835	Theory and Practice of Transportation Planning I	2
1.836	Theory and Practice of Transportation Planning II	2

1.916	Engineering Statistics I	2
1.917	Engineering Statistics II	2
1.993	Master's Report	4
	or	
1.991	Thesis	8

Suggested Technical Electives

Courses		Credits
1.207	Technology Assessment	4
1.809	Systems Analysis III	2
1.811	Urban Public Transportation	2
1.815	Urban Transportation Analysis I	2
1.816	Urban Transportation Analysis II	2
1.817	Traffic Engineering	2
1.820	Transportation Engineering	2
1.865	Environmental Impacts of Transportation I	2
1.866	Environmental Impacts of Transportation II	2
5.916	Engineering Analysis Utilizing Data Processing	2
5.960	Probability and Statistics I	2
5.961	Probability and Statistics II	2
5.962	Probability and Statistics III	2
5.913	Data Processing for Engineers	2
5.914	Advanced Operations Research	4

Suggested Non-Technical Electives

Courses		Credits
22.847	The Politics of Transportation	3
39.9L5	Economics of Urban Transp.	3
39.9P3	Regional Development	3
39.9R1	Development Planning	3
22.842	Techniques of Urban Planning	3
22.841	Problems in Urban Planning	3
39.9L7	Economics of Inter-City Transportation	3
48.805	Urban Transportation	3
48.801	Seminar in Intercity Transportation	3
39.9L1	Urban Economics I	3
39.9L2	Urban Economics II	3

ENVIRONMENTAL ENGINEERING

Includes areas of specialization such as water resources engineering, water and wastewater engineering, environmental health, air pollution control and solid waste management.

Part-time students and full-time students not on traineeships or grants-in-aid have the option of undertaking either a Master's Report for 4 q.h. credit or a Master's Thesis for 8 q.h. credit. (Students on traineeships or with grants-in-aid may be required to complete a Master's Thesis.)

Suggested programs for both full-time and part-time students are given below. Other programs, tailored to meet individual requirements, may be developed through conferences with the student's adviser.

SPECIMEN DAY PROGRAM

Fall Quarter		**Credits**
1.914	Water & Wastewater Treatment	4
*1.923	Environmental Chem.	4
1.933	Environmental Anal.	4
	Elective	2
		14

Winter Quarter		**Credits**
1.912	Water & Wastewater Treatment III	2
1.922	Env. Bacteriology	2
	Electives	10
		14

Spring Quarter		**Credits**
	Electives	4 or 8
1.993	Master's Report	4
	or	
1.991	Thesis	8
	(Minimum)	12

PART-TIME PROGRAM

Required Courses		**Credits**
1.910	Water & Wastewater Treatment I	2
1.911	Water & Wastewater Treatment II	2
1.912	Water & Wastewater Treatment III	2
*1.920	Env. Chemistry I	2
*1.921	Env. Chemistry II	2
1.922	Env. Bacteriology	2
1.930	Env. Analysis I	2
1.931	Env. Analysis II	2

* These required courses may be waived for those students who have taken Northeastern course 1.923, Environmental Chemistry, or equivalent. Course 1.933 or courses 1.930 and 1.931 will be required of all students.

1.993	Master's Report	4
	or	
1.991	Thesis	8
		20 or 24

Elective Groupings (Day and Part-Time)

Forty (40) quarter hours of academic work are required for the degree, including certain approved electives which are available from other departments. To provide a meaningful grouping of the available technical electives, one of the following sequences of courses must be selected. These are the required courses for each area of specialization. A minimum of 14 quarter hours of elective courses must be obtained from the environmental engineering courses offered by the Civil Engineering Department. Exceptions to these requirements must receive permission from the Environmental Engineering Graduate Committee.

Water and Wastewater Engineering		**Credits**
1.913	Industrial Waste Disposal	2
1.916	Engineering Statistics I	2
1.935	Unit Operations In Environmental Engineering I	2
1.936	Unit Operations in Environmental Engineering II	2
1.954	Stream Sanitation	2
	Additional Electives	6 or 10

Environmental Health Engineering & Science		**Credits**
1.985	Environmental Protection	2
1.980	Environmental Planning and Management	2
1.940	Public Health Engineering Survey	2
1.950	Air Pollution Engineering	2
1.952	Industrial Hygiene	2
1.955	Air Sampling and Analysis	2
	Additional Electives	4 or 8

Water Resources Engineering		**Credits**
1.888	Numerical Methods in Civil Engineering I	2
1.902	Open Channel Flow I	2
1.903	Open Channel Flow II	2
1.908	Hydrology I	2
1.909	Hydrology II	2
1.916	Engineering Statistics I	2
1.917	Engineering Statistics II	2
1.924	Flow Through Porous Media	2
1.925	Groundwater and Seepage	2
1.963	Hydraulic Structures I	2
1.964	Hydraulic Structures II	2
1.965	Water Resources Planning	2

Air Pollution Engineering		Credits
1.807	Systems Analysis I	2
1.808	Systems Analysis II	2
1.950	Air Pollution	2
1.955	Air Sampling & Analysis	2
1.957	Air Pollution Science	2
	Additional Electives	6 or 10

GEOTECHNICAL ENGINEERING

At the master's degree level, students may concentrate their studies in Geotechnical Engineering. This option is open only to those students who have an accredited undergraduate degree in Civil Engineering. Those without a Civil Engineering degree may enter the program only after completing a series of undergraduate Civil Engineering courses which will provide the necessary background. The extent of the undergraduate courses required for admission will depend on each individual's academic background.

Students electing the Geotechnical major must undertake either a Master's Report or Thesis and take twenty-six quarter hours of Civil Engineering courses within the Geotechnical Engineering field. The remaining 6 to 10 quarter hours of study may be elected from any offering in either Engineering or Science for which the student has the necessary prerequisites. Each student must elect the technical electives during the first year of study and have them approved by his academic adviser.

Required Courses		Credits
1.850	Seismic Design I	2
1.851	Selected Topics in Earthquake Engineering	2
1.871	Soil Mechanics I	2
1.872	Soil Mechanics II	2
1.873	Soil Mechanics III	2
1.874	Foundation Engineering I	2
1.875	Foundation Engineering II	2
1.876	Foundation Engineering III	2
1.882	Engineering Geology	2
1.884	Rock Mechancis I	2
1.885	Rock Mechanics II	2
1.886	Soil Dynamics I	2
1.887	Soil Dynamics II	2

Suggested Electives		Credits
1.888	Numerical Methods in Civil Engineering I	2
1.889	Numerical Methods in Civil Engineering II	2
1.849	Model Analysis	2

1.916	Engineering Statistics I	2
1.917	Engineering Statistics II	2
1.924	Flow Through Porous Media	2
1.925	Groundwater and Seepage	2
1.963	Hydraulic Structures I	2
1.964	Hydraulic Structures II	2
1.908	Hydrology I	2
1.909	Hydrology II	2
1.830	Construction Methods and Equipment I	2
1.831	Construction Methods and Equipment II	2
1.832	Legal Aspects of Civil Engineering I	2
1.833	Legal Aspects of Civil Engineering II	2

CONSTRUCTION ENGINEERING

This major consists of core courses primarily from the Civil Engineering Department. It is filled out with electives from the Civil Engineering, Industrial Engineering, and Engineering Management Departments, or from the Graduate School of Business Administration. Each student is required to prepare a program of study which must be reviewed and approved by a faculty adviser. Required courses are indicated in the program which follows. Program options emphasize technical, systems, or business aspects of Construction Engineering. Part-time students are subject to the same requirements as full-time students.

FULL-TIME PROGRAM

Fall Quarter

1.830	Construction Methods and Equipment I	2
1.832	Legal Aspects of Civil Engineering I	2
1.821	Cost of Construction Projects	2
5.810	Accounting for Engineers	2
	Electives	4
		12

Winter Quarter

1.822	Planning and Control of Construction Activities	2
1.831	Construction Methods and Equipment II	2
5.841	Engineering Project Management	2
1.833	Legal Aspects of Civil Engineering II	2
	Electives	6
		14

Spring Quarter

1.827	Construction Seminar	2
5.809	Advanced Engineering Economy	2
1.993	Master's Report	4
	or	
1.991	Thesis	8
	Electives	or 6
		14

PART-TIME PROGRAM

Part-time students are subject to the same requirement as full-time students. Some of the courses are not available in the evening, but appropriate substitutions may be made if students are given formal written approval by an academic adviser.

Elected Courses:

1. Students interested in a *Technical Emphasis* may choose from any appropriate Civil Engineering course or other engineering courses to fill out his or her program. This program must be approved by a faculty adviser.

2. Students interested in either a *Systems Engineering* or *Business Management Emphasis* would normally be expected to take 1.916, 1.917, 1.807–1.809, as appropriate to their programs and then choose the remaining requirements (up to a limit of 10 quarter hour credits) from courses in Industrial Engineering or the School of Business Administration such as:

Systems Engineering Emphasis		**Credits**
5.912	Network Planning and Control	2
5.817	Advanced Work Design	2
	or	
5.823	Advanced Production Analysis	4
5.904	Queuing Theory and Its Applications	2
5.905	Analysis with Simulation	2
5.916	Engineering Analysis Utilizing Data Processing	2
5.954	Advanced Quality Control	2
5.963	Statistics II	2
5.940	Basic Information System Technology	2
5.941	Management Information Systems	2
5.942	MIS: Planning, Control, and Development	2
	or	
49.918	Information Theory and Systems	3*
49.932	Introduction to Computer Applications	3*
49.933	Management Information Systems	3*

Business Management Emphasis

41.862	Tax Factors in Business Decisions	3*
45.965	Management of Small Business Enterprises	3*
45.968	Management of New Enterprises	3*
5.805	Industrial Budgeting for Engineers	2
45.972	Labor Relations	3*
5.862	Introduction to Occupational Health and Safety	2
5.863	Technical Aspects of Health and Safety	2
45.993	Labor Law	3*

THE DOCTOR'S DEGREE

Environmental Engineering
Full-Time Program

The following material outlines the procedures for admission to the doctoral program in environmental engineering and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Chairman of the Ph.D. Committee, Department of Civil Engineering.

Admission

Each student admitted to the program will initially have the status of doctoral student. In the usual case, he will have received a master's degree in an appropriate field of engineering or science prior to entry into the program. Applicants should apply to the Chairman of the Ph.D. Committee, Department of Civil Engineering for admission to the doctoral program, preferably by February 1st. The Committee will interview the applicants, examine their records, and decide whether they should be admitted to the program. The chairman of the department will appoint a program adviser for each doctoral student, upon the recommendation of the Ph.D. Committee.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work after admission as a doctoral student. However, it is expected that at least two years of full-time graduate study will be required beyond the master's degree.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations. At least one year of full-time study and successful completion of the qualifying examination are required for consideration as a doctoral degree candidate.

* The amount of credit applied toward the degree must be established by the Department.

Qualifying Examination

The qualifying examination will consist of a written and an oral section. The written part will cover: (1) environmental engineering and/or science and (2) selected areas depending upon the educational background and interest of the student. In certain cases the student may be exempted from the written part of the examination. The oral portion will measure general comprehension. If the oral examination is failed, it may be repeated with permission of the departmental graduate committee. The qualifying examination shall be completed no later than two years after admittance as a doctoral student. After successful completion of this examination the student will be given the status of doctoral candidate.

Comprehensive Examination

The comprehensive examination is given after the thesis has been completed. This examination is based upon the defense of the thesis.

Course Requirements

Course requirements for each applicant will be determined by the Ph.D. Committee. Formal course work will be selected to meet the individual student's objectives. Graduate level study up to 12 quarter hours of course work completed under programs other than this full-time program may be accepted with approval of the committee.

Thesis

After degree candidacy has been established, a candidate must complete a thesis which embodies the results of extended research and includes material suitable for publication.

A thesis committee will be appointed by the chairman of the Ph.D. Committee. The thesis committee, consisting ordinarily of five members, two of whom are from other departments, will be informed of the progress of the thesis and will be responsible for its approval.

Language Requirement

A reading knowledge of one foreign language is required. The requirement shall be determined in a manner prescribed by the committee, and must be satisfied prior to taking the oral qualifying examination.

mechanical engineering

The Department of Mechanical Engineering offers the degrees of Master of Science in Mechanical Engineering, Mechanical Engineer, and Doctor of Philosophy. The Master of Science degree can be pursued on either a full-time or a part-time basis. A full-time student may apply for participation in the Cooperative Plan. The Mechanical Engineer and Doctor of Philosophy degrees are pursued on a basis consistent with the residence requirements for the degree. The curriculum offers areas of concentration in Mechanics, Thermofluid Engineering, and Materials Science and Engineering.

THE MASTER OF SCIENCE DEGREE

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Mechanical Engineering, applicants must have obtained from a recognized college or university the degree of Bachelor of Science in Mechanical Engineering, or a closely-allied engineering field, with an acceptable quality of undergraduate work. Applicants with a Bachelor of Science degree in other engineering or related science fields and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science without specification.

Area of Concentration

Each student must complete the required courses in one area of concentration to be eligible to receive the degree. It is expected that these courses will be completed as early as possible in his academic program. The elective courses in each area of concentration should be chosen with the aid of the student's adviser.

Required Courses

Mechanics		**Credits**
2.826	Math. Methods for Mech. Eng. I	2
2.827	Math. Methods for Mech. Eng. II	2
2.804	Theory of Elasticity	2
	and	
2.805	Theory of Elasticity	2
	or	
2.819	Fluid Dynamics I	2
	and	
2.820	Fluid Dynamics II	2
2.841	Vibration Theory	2
	and	

2.842	Vibration Theory	2
	or	
2.849	Automatic Cont. Eng.	2
	and	
2.850	Automatic Cont. Eng.	2
	and	
2.851	Automatic Cont. Eng.	2
		12 or 14

Thermofluid Engineering **Credits**

2.826	Math. Methods for Mech. Eng. I	2
2.827	Math. Methods for Mech. Eng. II	2
2.819	Fluid Dynamics I	2
2.820	Fluid Dynamics II	2
2.901	Adv. Thermodynamics	2
2.902	Adv. Thermodynamics	2
2.910	Conduction Heat Trans.	2
2.911	Convection Heat Trans.	2
		16

Materials Science and Engineering **Credits**

2.826	Math. Methods for Mech. Eng. I	2
2.827	Math. Methods for Mech. Eng. II	2
2.954	Adv. Physical Met. I	2
2.956	Adv. Physical Met. II	2
2.970	Mat. Sci. and Eng.	2
2.971	Mat. Sci. and Eng.	2
2.804	Theory of Elasticity	2
	or	
2.960	Thermo. of Materials	2
	and	
2.961	Thermo. of Materials	2
		14 or 16

In addition, Seminar (2.990 and 2.998) and Thesis (2.991) are required for continuous full-time and cooperative plan students in all areas of concentration.

Electives

Students must take sufficient mechanical engineering departmental electives so that the required courses in their major area and the departmental electives total at least 30 of the 40 quarter hours required for the degree.

The remaining ten credits may be elected from any courses in engineering or science for which the student has the necessary preparation.

Full-Time Program on the Cooperative Plan

The cooperative program may be taken on an alternating or parallel schedule as set forth under the regulations of the Graduate School. Placement in a work assignment is not guaranteed by the University since placement is a function of the availability of positions and the academic background and job-related experience of students.

The thesis, seminar, and specified courses are the same as required by the continuous full-time program.

Continuous Full-Time Program

Students may take the 40 quarter hours of academic work on a continuous full-time basis. A thesis of ten quarter hours of credit and two seminar courses are required of all continuous full-time students in addition to the specified courses in an area of concentration. The sequence of courses which students take on this plan is established by their adviser.

Part-Time Program

The admission and graduation requirements for the evening part-time program are the same as for the full-time program, but students may progress according to their abilities and the time available. All courses in one area of concentration must be completed by part-time students. The thesis and seminar courses are not required.

Advisers for Part-Time Programs

The following faculty members of each area of concentration should be contacted if information is required relative to any academic problems.

Mechanics ..... Professor John N. Rossettos
Thermofluid Engineering ..... Professor Warren G. Nelson
Materials Science and Engineering ..... Professor Richard J. Murphy

THE MECHANICAL ENGINEER DEGREE

The degree of Mechanical Engineer is offered for those who wish to undertake graduate study beyond the Master's degree without committing themselves to a program as extensive as that required for the Doctor's degree. The degree permits a candidate to pursue a course of study at the upper graduate level in more than one area of Mechanical Engineering as distinguished from the specialization usually associated with the doctoral program.

The following material outlines the requirements for the Mechanical Engineer degree. For further information applicants should write to the Chairman of the Graduate Committee, Department of Mechanical Engineering, Northeastern University, Boston, Massachusetts 02115.

Admission

To be admitted to candidacy for the degree of Mechanical Engineer, the applicant will have obtained the degree of Master of Science in Mechanical Engineering, or its equivalent, from a recognized institution. In some cases, where the Master's degree is not in Mechanical Engineering, the applicant may be admitted to the program on a conditional basis with the stipulation that certain deficiencies be removed without credit toward the degree. Such special admission is dependent upon the approval of the Mechanical Engineering Graduate Committee.

In general, an applicant will choose two areas of concentration to give him the broad background which characterizes the degree of Mechanical Engineer. An outline of his program must be submitted to the Graduate Committee for approval before final action can be taken upon his application. It is recommended that the applicant discuss his program with the Graduate Committee and members of the graduate faculty in his areas of concentration prior to submission of his program for approval.

Each applicant must submit to the Graduate Committee prior to March 1: (1) transcripts of his undergraduate and graduate records, (2) three letters of recommendation which indicate his ability to carry out advanced graduate work, and (3) the program of study which he proposes to follow.

Classification and Degree Candidacy

A student admitted to the Mechanical Engineer degree program will be designated as a Candidate for this degree. The Candidate's adviser normally will be the faculty member who will supervise the dissertation.

Residence Requirement

The residence requirement is satisfied by two academic quarters of full-time graduate work during the academic year or by four academic quarters of half-time graduate work during two consecutive academic years. Plans for satisfying the residence requirement on a half-time basis must be approved by the Graduate Committee.

Qualification and Examinations

A student must maintain a 3.00 grade point average to qualify for the degree. Students admitted on a conditional basis may be required to pass special examinations. The Graduate Committee will determine the need for and will administer any such special examinations. A final oral examination consisting of a defense of the dissertation may be required if the Candidate's adviser and the Departmental Graduate Committee so decide.

Credit Requirements

A minimum of 40 quarter hours of credit beyond the Master's degree is required. Up to 10 quarter hours of credit will be permitted for work on a

dissertation. A minimum of 20 quarter hours of credit must be in the Mechanical Engineering Department.

Dissertation

To be awarded the Mechanical Engineer degree, each candidate must complete a dissertation demonstrating a high level of competence in research, development, or design in the field of Mechanical Engineering. The effort normally expected will be the equivalent of 10 quarter hours of graduate course work.

Transfer Credits

Any transfer of credits must be approved by the Mechanical Engineering Graduate Committee.

Time Limitation

After admission to the program, a maximum of five years will be permitted for completion of the degree.

Registration

After approval of the Candidate's program, registration must be continuous. Withdrawal or changes in the program must be approved by the Graduate Committee.

THE DOCTOR OF PHILOSOPHY DEGREE

The degree of Doctor of Philosophy is awarded to those candidates who demonstrate high attainment and research ability in the field of Mechanical Engineering.

The following material outlines the requirements for the Doctor of Philosophy degree. For further information applicants should write to the Chairman of the Department of Mechanical Engineering, Northeastern University, Boston, Massachusetts 02115.

Admission

The program leading to the Ph.D. degree is open to persons who are candidates for the Master of Science in Mechanical Engineering degree as well as those who have received the degree. Requests for admission to the program should be made to the Chairman of the Department of Mechanical Engineering. Applicants will receive an application for interview form. This form, along with transcripts of all undergraduate and graduate work and three letters of recommendation, must be returned to the Chairman of the Graduate Committee of the Department of Mechanical Engineering by November 1. The applicant will be notified of an interview time. Based upon an evaluation of applicants'

qualifications, the Graduate Committee will inform applicants whether or not they will be admitted to the program.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or by two years of half-time graduate work beyond the Master's degree. However, a student should expect to spend at least two years, or the equivalent, in full-time graduate study beyond the requirements of the Master's degree.

Degree Candidacy

After 40 quarter hours of graduate work have been taken with satisfactory grades and upon successful completion of the qualifying examination, a student is established as a degree Candidate.

Qualifying Examination

The qualifying examination in the Department of Mechanical Engineering is offered yearly in January and is both written and oral. The written portion of the qualifying examination is six hours in length and covers, with equal emphasis, four different areas. A student must select one area from each of the three groups A, B, and C, plus another area either listed below or unlisted, but considered equivalent and approved by the Graduate Committee.

A. Concepts of Thermodynamics
Applied Thermodynamics

B. Dynamics
Mechanics of Deformable Bodies

C. Heat and Mass Transfer
Fluid Mechanics
Mechanical Behavior of Materials
Physical Metallurgy

The oral portion of the qualifying examination is conducted by a committee consisting of at least four members appointed by the Graduate Committee. A typical committee is composed of two members specializing in the student's major area plus one member from each of two other areas.

The qualifying examination may be taken by a graduate student who expects to complete the requirements for his Master's degree within three months of the date of the qualifying examination as well as by a person who has already completed the requirements for the Master's degree. Because degree candidacy must be established before the Graduate Committee will act to approve course programs or dissertation proposals, the qualifying examination should be taken at the earliest opportunity. If the examination is failed, it may be repeated with permission of the departmental Graduate Committee.

Course Requirements

To receive the Ph.D. degree a candidate must complete a program of course work approved by the Graduate Committee. Courses completed prior to admittance to the doctoral program are subject to the approval of the Graduate Committee. Each program must contain at least twelve quarter hours of course work, preferably outside of the department, in an area other than that in which the candidate is concentrating. Attainment of a 3.00 grade point average for the courses in the "minor" portion of the program will signify satisfactory completion of that portion.

Dissertation

After degree candidacy has been established, a candidate must complete a dissertation which embodies the results of extended research and includes materials suitable for publication.

The departmental Graduate Committee may require the completion of certain course work before permitting dissertaton work to commence. A Dissertation Committee will be appointed by the Chairman of the department upon the recommendation of the departmental Graduate Committee. The Dissertation Committee will be kept informed of the work and will be responsible for initial approval of the dissertation in its final form.

Language Requirement

A reading knowledge of one foreign language is required. Proficiency in a language shall be determined in a manner prescribed by the departmental Graduate Committee. The language requirement must be fulfilled within six months after the dissertation proposal has been accepted but no less than six months before the degree is granted.

Comprehensive Examination

The comprehensive examination is combined with the final oral examination and is given after the dissertation has been completed and approved. This examination is based upon the subject matter of the dissertation and a defense of it.

Final Oral Examination

The final oral examination is taken after completion of all other requirements for the degree. This examination cannot be held until two weeks have elapsed after the dissertation has been registered and accepted by the Graduate School and must be passed at least two weeks before the commencement at which the degree is to be awarded.

The final oral examination will include the subject matter of the doctoral dissertation and significant developments in the field of the dissertation work. Other fields may be included if recommended by the examining committee.

electrical engineering

Admission

To be enrolled for graduate work leading to the degree of Master of Science in Electrical Engineering, applicants must have obtained a Bachelor of Science degree in Electrical Engineering, with an acceptable quality of undergraduate work, from a recognized college or university. Applicants with a Bachelor of Science degree in other engineering or related science fields and an appropriate background of preparation may pursue this program and qualify for the degree of Master of Science without specification. In some cases, students whose Bachelor of Science degree is in some other engineering or related science field may qualify for the degree of Master of Science in Electrical Engineering. This requires special approval of the Department of Electrical Engineering.

THE MASTER'S DEGREE

Full-Time Program on the Cooperative Plan

The full-time program on the Cooperative Plan may be pursued on either the alternating or parallel schedules. Both programs require a minimum of an eighteen-month commitment for completing degree requirements. Students who are admitted to a Master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment to be eligible for the degree. Please refer to the section describing the regulations of the Graduate School for a more complete description of the cooperative education programs.

Continuous Full-Time Programs

Students may take academic work on a continuous full-time basis and complete degree requirements in one academic year. The sequence of courses which students take on this plan is established by their adviser.

GENERAL PROGRAM

Full-Time Course Requirements

Electrical Engineering

Forty quarter hours of academic work are needed for a Master's degree. The following courses are required of all full-time students:

Required Courses

3.823	Mathematical Methods in Electrical Engineering	4
3.827	Linear Systems Analysis	4

3.832	Network Synthesis	4
3.842	Linear Active Circuits	4
3.877	Electromagnetic Theory	4
3.902	Applied Prob. and Stoch. Processes	4
3.990	Seminar I	2
3.991	Seminar II	2
		28

A limited amount of work may be elected from the part-time program.

A thesis for six quarter hours credit is elective with the approval of the chairman of the department. If the thesis option is approved, this work is done in the second year of the program. Details concerning thesis proposals, editorial format, and time schedules are available in the Graduate School Office.

The program of each student will be made up from the required and elective courses available in each term and approved by the student's academic adviser.

POWER SYSTEMS MAJOR

The Electrical Engineering Department offers a variety of graduate courses which may be of interest to those designing, operating, and maintaining electric energy systems. Since the program is utilized primarily by part-time M.S. students, the courses are offered at night and on a staggered schedule. Some of the more specialized topics listed are offered only on demand, so students interested in such offerings are encouraged to make their wishes known.

Students wishing to major in Power Systems may petition to take 3.926–27 (Power Circuit Analysis) in place of 3.840–41 (Linear Active Circuits). Both are normally offered yearly. Otherwise, the course requirements are essentially the same for Power Systems as for any of the other major areas. The student's attention is directed to the requirements for major and minor areas described under Electives (see page 66). Courses listed there under the Power Systems heading include offerings from both Electrical Engineering and Mechanical Engineering. All of the courses so listed may be used in either a *major* or a *minor* as appropriate. For any other courses outside of Electrical Engineering, specific prior approval is required. It is always advisable to get approval for a complete program of study before beginning any part thereof. For students majoring in Power Systems, the appropriate approval may be obtained from the Director of the Power Systems Program.

Full-Time Program on the Cooperative Plan

The full-time program on the Cooperative Plan may be pursued either on the alternating or parallel schedules. Students who are admitted to a Master's degree program under the Cooperative Plan must complete, through satisfactory performance, each cooperative work assignment to be eligible for the degree. Please refer to the section stating the regulations for the Graduate School for a more complete description of the cooperative education programs. The course requirements may vary with a student's background; deviations to

the program previously described may be made in consultation with your adviser.

Continuous Full-Time Program

Students may take academic work on a continuous full-time basis and complete degree requirements in one academic year. The sequence of courses which students are required to complete will be made in consultation with an adviser.

Part-Time Program
Electrical Engineering

Admission

The admission requirements for the part-time program leading to the degree of Master of Science in Electrical Engineering are the same as for the full-time program, but students may progress according to their abilities and the time available.

All graduate courses presuppose mastery of the subject matter of a modern, fully accredited curriculum in electrical engineering. Applicants who have not taken further academic work for some time since they received their bachelor's degree may be required to take graduate courses to satisfy any deficiencies. For this purpose, the following courses are available:

Prerequisite Courses		Credits
3.975	Precis of Modern Electrical Engineering I	2
3.976	Precis of Modern Electrical Engineering II	2
3.977	Precis of Modern Electrical Engineering III	2
3.978	Precis of Modern Electrical Engineering IV	2

These courses carry graduate credit but a maximum of four quarter hours of credit from this group may be used as elective credit in the degree program.

Program

Forty quarter hours of academic work are required for the master's degree of which 16 quarter hours of credit are specified as follows:

Required Courses		Credits
3.825	Linear Systems Analysis II	2
3.826	Linear Systems Analysis III	2
3.840	Linear Active Circuits I	2
3.841	Linear Active Circuits II	2
3.875	Electromagnetic Theory I	2
3.876	Electromagnetic Theory II	2

3.8C1	Mathematical Methods in Electrical Engineering I	2
and		
3.8C2	Mathematical Methods in Electrical Engineering II	2
or		
3.8C4	Mathematical Methods in Electrical Engineering III	2
and		
3.8C5	Mathematical Methods in Electrical Engineering IV	2
or		
3.900	Applied Probability and Stochastic Processes I	2
and		
3.901	Applied Probability and Stochastic Processes II	2

Students lacking the necessary prerequisites for 3.8C1 or 3.8C4 may be required to take undergraduate courses 3.292 or 3.293 to clear this deficiency. By petition, these courses may carry graduate credit.

Electives

In addition to the required course work each student is expected to select a major and a minor area form the list given below. Ten quarter hours of credit must be taken in the major area and six quarter hours of credit taken in the minor area. The area or areas to which a course is assigned is indicated in the following listings. Not every course is assigned to an area. They may be used as one of the free elective courses. Eight quarter hours of credit are free electives which may be selected from graduate courses in sciences or other engineering departments for which the student has the necessary preparation.

Subject Areas

1. Circuits and Systems

3.830		3.911
3.831		3.912
3.832	3.843	3.950
3.833	3.845	3.951
3.834	3.860	3.952
3.835	3.861	3.953
3.837	3.910	3.954

2. Computer Science

3.837	3.8T0	3.937	3.986
3.860	3.8T2	3.966	3.987
3.861	3.8T3	3.967	3.988
3.893	3.8T7	3.968	3.989
3.894	3.8T8	3.969	3.9A1
3.895	3.8T9	3.972	3.9A2
3.898	3.8U4	3.973	3.9B1
3.899	3.8U7	3.974	3.9D1
3.8A1	3.935	3.979	3.9E1
3.8T1	3.936	3.985	3.9E2

3. Fields, Waves and Optics

3.800	3.817	3.890	3.923
3.801	3.818	3.891	3.980
3.802	3.819	3.913	3.981
3.806	3.878	3.914	3.982
3.807	3.879	3.915	3.983
3.808	3.880	3.916	3.984
3.810	3.881	3.917	
3.811	3.882	3.921	
3.812	3.883	3.922	

4. Communications and Control

3.817	3.898	3.908	3.965
3.818	3.899	3.909	3.9A1
3.819	3.900	3.9C1	3.9A2
3.865	3.901	3.9C2	3.9A6
3.866	3.902	3.957	3.9A7
3.867	3.903	3.958	3.9A8
3.871	3.905	3.959	
3.872	3.906	3.963	
3.873	3.907	3.964	

5. Physical Electronics

3.806	3.808	3.854	3.8G2
3.807	3.853	3.8G1	3.8G3

6. Power Systems

2.901	2.942	3.931	3.942
2.902	2.943	3.932	3.944
2.920	2.944	3.933	3.945
2.921	3.925	3.935	3.955
2.935	3.926	3.936	3.956
2.936	3.927	3.940	
2.938	3.930	3.941	

Quarter-Sequence Courses

Certain courses have an A or B after the course title. In these cases, credit will be given toward the degree only if both the A and B courses are successfully completed.

COMPUTER SCIENCE MAJOR

The Computer Science Program is structured to provide a curriculum of study in computer science and engineering leading to the degree of Master of Science in Electrical Engineering, or Master of Science, with a major in Computer Science.

Admission

To be enrolled for this degree program, applicants must have obtained a Bachelor of Science degree in engineering, mathematics, or the physical sciences from a recognized college or university and must present satisfactory evidence of ability to pursue graduate study. Students who do not hold a Bachelor of Science degree in Electrical Engineering may be required to complete an appropriate undergraduate prerequisite program to be determined at the time of acceptance.

Program

Forty quarter hours of academic work are required, of which 14 are specified and 26 are elective.

Specified Courses		Credits
3.893	Digital Computer Programming I	2
3.894	Digital Computer Programming II	2
3.972	Digital Computer Design I-A	2
3.973	Digital Computer Design I-B	2
3.8A1	Mathematical Methods in Computer Science	2
3.8T1	Numerical Methods and Computer Applications I	2
3.8T2	Numerical Methods and Computer Applications II	2

Electives

Sixteen quarter hours of credit must be chosen from the following list of courses. It is urged that students take both of the courses in any two-quarter sequence they elect, and at least two courses in any three-quarter sequence they elect.

3.837 Introduction to Graph Theory
3.895 Digital Computer Programming III
3.898 Combinatorial & Optimization Techniques I
3.899 Combinatorial & Optimization Techniques II
3.8T3 Numerical Methods and Computer Applications III
3.8T7 Digital Signal Processing I
3.8T8 Digital Signal Processing II
3.9A1 Error Correcting Coding I
3.9A2 Error Correcting Coding II
3.9E1 Compiler Construction I-A *
3.9E2 Compiler Construction I-B *
3.908 Special Topics in Communication Theory
3.966 Switching Theory I
3.967 Switching Theory I-A *
3.968 Switching Theory I-B *
3.969 Switching Theory II
3.974 Digital Computer Design II
3.985 Fundamentals of Language and Machine Theory I
3.986 Fundamentals of Language and Machine Theory II
3.987 Fundamentals of Language and Machine Theory III
3.988 Special Topics in Computer Science
3.989 Computer Peripherals
3.995 Thesis
3.998 Special Problems in Electrical Engineering
5.911 Linear Programming
5.916 Engineering Analysis Utilizing Data Processing
5.941 Management Information Systems

Students must take sufficient electrical engineering departmental courses to total 30 of the 40 quarter hours required for the degree.

Thesis

A thesis carrying six credits may be elected with the approval of the chairman of the department. If the thesis option is approved, this work is done in the second half of the program.

---

* Both A and B courses must be successfully completed to receive credit.

THE DOCTOR'S DEGREE

Full-Time Program

The following material outlines the procedures for admission to the doctoral program and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Secretary, Department of Electrical Engineering.

Admission

Students who are interested in pursuing a doctor's program, should contact the **Electrical Engineering Department** to request an application. Completed applications, together with transcripts of all prior work and two letters of recommendation, should be forwarded to the Electrical Engineering Department, 409 Dana Hall, no later than January 1 of the preceding year. Following evaluation of this material, the applicant will be informed whether or not he will be permitted to undertake the qualifying examination. A personal interview is not required, but a student may arrange with the Secretary of the Electrical Engineering Graduate Committee, Professor Robert N. Martin (617–437–3041), for an appointment for further program details if desired. A student who has received approval to take the qualifying examination is considered a pre-doctoral student until such time as he passes the examination. **Upon successful completion of the qualifying examination he becomes a Ph.D. candidate.**

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or two consecutive years of part-time graduate work. In the latter case, a detailed time schedule must be approved by the student's adviser in order to give evidence that at least half of the time is being devoted to the requirements of the graduate school program.

Qualifying Examination

First, and foremost, the Ph.D. Qualifying Examination is the entrance examination for admission to the doctoral program. In addition, this examination has the dual purpose of one: serving as an indicator of the student's capability for successful completion of the program, and two: serving as a guide to his adviser in developing a suitable plan of study tailored to the individual needs of the candidate.

With these goals in mind, the candidate is urged to take the qualifying examination early in his graduate program (i.e., not later than the successful completion of 40 quarter hours of graduate work).

The examination is composed of a written and an oral part, and is usually given in the spring quarter of each academic year. The written part covers the following general categories:

(1) Circuits and Electronics

(2) Fields, Waves, and Energy Conversion
(3) Systems
(4) Miscellaneous Topics in Electrical Engineering

The oral part is designed to test general comprehension. Together, the oral and written portions of the examination review the factual knowledge of a typical undergraduate Electrical Engineering program and the understanding of that material from a more mature point of view.

If the examination is failed it may be repeated only with permission of the Graduate Committee upon recommendation of the Ph.D. Qualifying Examination Committee.

Comprehensive Examination

Within three years of his establishment of degree candidacy, the student will be required to demonstrate by means of a comprehensive examination a subject matter knowledge satisfactory for the award of the degree.

The comprehensive examination is an oral examination open to the Electrical Engineering faculty (assistant professor and above in rank) and administered by the student's Thesis Committee. Departmental faculty will be informed of the examination via a departmental notice at least one week prior to the examination. Normally the examination will be given at the time the Thesis Proposal is submitted to the Thesis Committee for approval. As part of this examination the Thesis Committee will review the student's doctoral program and his performance in graduate courses, as well as examine the student on subject matter related to his graduate studies and his thesis area.

Course Requirements

Successful completion of a doctoral program normally requires a minimum of 70 quarter hours of satisfactory graduate level work beyond the B.S. degree, exclusive of doctoral seminar (required), doctoral reading, and doctoral thesis.

The course work must include a three-course sequence (graduate level) in each of two minor areas. Both minors must be in science, applied science, or a related area. One minor may be chosen from an area of electrical engineering outside the candidate's proposed major area.

Thesis

The candidate's thesis research shall be directed by his Thesis Adviser, whom he shall select upon establishing candidacy. The Thesis Committee shall approve the thesis in final form.

Language Requirement

The language requirement may be satisfied in French, German, or Russian, with an additional option of English for Ph.D. candidates for whom English is

not the native language. * Information on these exams may be obtained from the Department Office, 411 Dana.

Final Oral Examination

This examination will be held in accordance with the departmental regulations.

THE ELECTRICAL ENGINEER DEGREE

The Department of Electrical Engineering offers the graduate professional degree usually known as the Engineer Degree. This degree, offered at a number of institutions, usually requires about one year of full-time graduate study beyond the master's degree. The official title of the degree is "Electrical Engineer".

The following material outlines the procedures for admission to the Electrical Engineer degree program and the steps necessary to qualify for the degree. for further information applicants should write to the Department of Electrical Engineering.

Admission

A master's degree in engineering or a related field with a better than 3.00 grade point average and the approval of the departmental graduate committee is required for admission. In some cases, where the master's degree is not in Electrical Engineering, a student may be admitted to the program with the stipulation that certain preparation be completed without credit toward the degree.

The applicant must complete the following documentation:

1. An application form (apply to the E.E. Dept. office)
2. Two letters of recommendation
3. Transcripts of all college-level work
4. A written statement setting forth the student's educational and career goals
5. Results of the Test of English as a Foreign Language (TOEFL) examination for international students.

Applications must be completed and on file no later than January 1 of the preceding year. An interview will be scheduled with a faculty member prior to the final review by the Graduate Committee. Graduate Committee reviews will be held some time during the spring quarter.

The Engineer Degree is available on either a full- or a part-time basis.

Classification and Degree Candidacy

A student admitted to the Engineer Degree program will be designated as a candidate for this degree.

---

* Only with written permission of candidate's adviser.

Residence Requirement

The residence requirement is satisifed by two academic quarters of full-time graduate work during the same academic year or part-time graduate work during a period of two consecutive academic years subject to approval of adviser.

Qualification and Examinations

A student must maintain a 3.00 grade point average and receive no "F's" in order to qualify for the degree. In some instances, a student may be required to take special examinations. Such examinations will be determined in each case by the departmental graduate committee.

Course Requirements

The minimum course requirements are 40 quarter hours beyond the master's degree. No more than 10 out of the 40 quarter hours of credit are allowed for thesis and special problems combined. A minimum of 20 quarter hours must be taken in regularly scheduled electrical engineering subjects. The student's course program must be approved by the adviser.

Dissertation

Each engineer degree student must complete a dissertation which demonstrates a high level of competence in research, development, or design in the field of electrical engineering. Thesis registration must total at least 6 quarter hours of graduate work. In no case will more than 10 quarter hours be credited towards the degree requirements.

In some cases a master's thesis of superior quality may be used to satisfy the thesis requirement. The thesis supervisor has responsibility for acceptance of the thesis.

Prior to submission of the thesis for acceptance the student must make a thesis presentation to be arranged by the adviser, who will provide reasonable notice to all Electrical Engineering faculty and others who may be interested. The thesis supervisor has responsibility for acceptance of the thesis.

Language Requirement

No foreign language is required for the Electrical Engineer degree.

Final Oral Information

A final oral examination consisting of a defense of the dissertation may be required if the student's adviser or the departmental graduate committee so decide.

Transfer of Credits

Approval for transfer of credit may be given by the departmental graduate committee upon written request from the student. Such requests should be

submitted at the time of applicaton to the program. A maximum of 10 quarter hours of credits may be transferred from another school but transfer credits for thesis are not allowed.

Time Limitation

After admission to the program, a maximum of three years will be allowed for completion of the degree requirements. Extension of this time limit may be granted by the departmental graduate committee.

Registration

All candidates must register for a **minimum** of 4 quarter hours of course work **each** quarter as approved by their academic adviser. After initial registration, registration must be continuous unless withdrawal is approved by the departmental graduate committee.

chemical engineering

The Department of Chemical Engineering offers the degrees of Master of Science in Chemical Engineering, Doctor of Engineering, and Doctor of Philosophy. The Master of Science degree may be pursued on either a full-time or a part-time basis. A full-time student may apply for participation in the Cooperative Plan. The Doctor of Engineering and Doctor of Philosophy degrees are pursued on a basis consistent with the residence requirements for the degree.

THE MASTER'S DEGREE

Admission

To be enrolled for graduate work in Chemical Engineering, applicants usually have obtained a Bachelor of Science degree in Chemical Engineering, with an acceptable quality of undergraduate work from a recognized college or university. However, qualified students with other B.S. or B.A. degrees in science or engineering may be admitted. Such students are required to complete supplementary undergraduate work in addition to the usual M.S. program in order to qualify for the M.S. degree in Chemical Engineering. Complete programs for these students are worked out after the student has made formal application to the program through the Graduate School of Engineering. The undergraduate work required is strongly dependent on the mathematics, chemistry, and engineering background of the applicant. The undergraduate course work in such programs may not be used for degree credit and must be pursued on a full-time (non-cooperative education) basis.

Full-Time Program on The Cooperative Plan

The full-time program on the Cooperative Plan may be pursued either on the alternating or parallel schedule. Both programs require a minimum of an eighteen month commitment for completing degree requirements. Students who are admitted to a Masters degree program under the Cooperative plan must complete, through satisfactory performance, each cooperative work assignment to be eligible for the degree. Please refer to section stating the regulations of the Graduate School for a more complete description of the Cooperative Education programs.

Continuous Full-Time Programs

Students may take academic work on a continuous full-time basis and complete degree requirements in one academic year. The sequence of courses which students take on this plan is established by their adviser.

Credit and Course Requirements

The Master of Science degree in Chemical Engineering is awarded to students who have satisfactorily completed an approved program of forty quarter hours of correlated work of graduate caliber. A minimum of thirty quarter hours of credit must come from graduate course offerings in Chemical Engineering. At least six of the Chemical Engineering courses must carry four quarter hours of credit. All four quarter hour courses offered by the department except those involving individual (project-type) work are acceptable in meeting this requirement. Research Techniques I and II (4.833 and 4.834) and/or M.S. Thesis (4.991) are required only for students who wish to pursue the department's doctoral programs. However, these courses may be taken by other students when their career objectives deem them advisable. Courses taken outside the department which are to be used for degree credit must be approved in advance by the department's graduate adviser.

Chemical Engineering Electives

At least two Chemical Engineering Electives will be scheduled each academic quarter. Consult the course SCHEDULE bulletin of the Graduate School of Engineering for the offerings in the current academic year. Possible offerings are:

Fall Quarter:

4.802 Chemical Engineering Mathematics
4.829 Chemical Process Control
4.870 Polymer Science
4.890 Heterogeneous Catalysis

Winter Quarter

4.811 Chemical Engineering Thermodynamics
4.823 Transport Phenomena
4.840 Advanced Management Techniques in the Chemical Industry
4.978 Separation Processes
4.974 Selected Topics in Fluid Mechanics

Spring Quarter

4.806 Optimization Techniques
4.838 Modeling and Simulation of Chemical Processes
4.845 Advanced Plant Design Concepts
4.850 Chemical Process Pollution Control (Water)
4.973 Chemical Process Heat Transfer
4.891 Kinetics of Chemical Processes

PART-TIME PROGRAM

The admission requirements for this program are the same as for the full-time program, but students may progress according to their ability to combine their study with their employment. This program is open only to students who possess a B.S. degree in Chemical Engineering. The credit and course requirements for this program are the same as for the full-time cooperative program. The department will offer two 4 quarter hour graduate courses in the late afternoon time period to assist part-time students in meeting degree requirements. A maximum of seven years is allowed for completion of this program.

Students wishing to switch their status from part-time to full-time M.S. candidates must notify the Chemical Engineering Department and make formal application with the Graduate School of Engineering. Such requests are usually granted for the full-time program to begin in the fall quarter.

THE DOCTOR OF PHILOSOPHY DEGREE

The following material outlines the procedure for admission to the doctoral program and the steps necessary to qualify for the Ph.D. degree. For further information applicants should write to the Chairman of the Department of Chemical Engineering.

Admission

Applicants who are enrolled as candidates for the degree of Master of Science in Chemical Engineering at Northeastern University should apply in writing to the Chairman of the Department of Chemical Engineering for admission to the doctoral program. Such application must be made by April first of the year in which they expect to receive the master's degree. The departmental graduate committee will examine the record of the applicant and decide whether or not he should be allowed to take the qualifying examination.

Applicants who are enrolled for graduate work at other institutions or who have completed the requirements for the master's degree should write the chairman of the department for an application for an interview. This form, together with transcripts of all undergraduate and graduate work, must be transmitted to the chairman of the departmental graduate committee. The applicant will be notified of an interview time and, after the interview, will be advised if he should make formal application for admission to the doctoral program. Approved applicants must submit an application for admission as a doctoral candidate and two letters of recommendation not later than April first. The applicant will be notified of the acceptance of his application and the date of the qualifying examination.

Residence Requirement

The residence requirement is satisfied by one year of full-time graduate work or two consecutive years of part-time graduate work. In the latter case, a detailed time schedule must be approved by the departmental graduate committee as

evidence that at least half of the time is being devoted to the requirements of the graduate school program. In general, it should be expected that at least two years of full-time work after establishment of degree candidacy will be necessary.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

The qualifying examination includes both written and oral parts and is normally given in the spring and the fall. The written examination, in general, will cover the following areas:

1. General Principles in Chemical Engineering Science
2. Thermodynamics and Stoichiometry
3. Mathematical Procedures and Kinetics
4. Specialized Technological Topics (to be announced)

The oral examination will test general comprehension.

A student may take a written examination in each area each time they are given; and may repeat a failed examination, only once, at a later offering. Successful completion of all examinations may not extend over a period greater than 13 months. Previously administered examinations will be available to formal applicants.

Comprehensive Examination

During the time in which a student is a candidate for a doctoral degree he or she may be required to demonstrate by means of a comprehensive examination a subject-matter knowledge satisfactory for the award of the degree.

Course Requirements

The course requirements in addition to the minimum requirements for establishing degree candidacy will be determined by the departmental graduate committee and the student in consultation with the committee.

Transfer credit will be dealt with on an individual basis by the departmental graduate committee in accordance with the general graduate school regulations.

Thesis

An individual may choose his thesis topic and supervisor as soon as he becomes a doctoral student. In most cases selection of topic will be made immediately after the student has established his candidacy for the Ph.D. degree. He will be expected to discuss with the staff their Ph.D. thesis topics offerings. After these discussions, the student shall notify the adviser, the de-

partment head, and the chairman of the departmental graduate committee in writing of his choice of thesis topic and adviser. The chairman of the departmental graduate committee after consultation with the thesis adviser shall appoint an appropriate thesis committee. This committee shall be kept informed of the progress of the thesis and will approve the thesis in its final form.

Language Requirement

The foreign language requirement may be satisfied by a reading knowledge in two languages selected from French, German, and Russian. The examinations are administered by the department and consist of translation from current scientific journals or textbooks.

Final Oral Examination

This examination is held in accordance with the general regulations of the graduate school.

THE DOCTOR OF ENGINEERING DEGREE

The following material outlines the procedure for admission to the doctoral program and the steps necessary to qualify for the Doctor of Engineering degree. For further information, applicants should write to the Chairman of the Department of Chemical Engineering.

Admission

Applicants for the Doctor of Engineering program must either be candidates for the Master of Science degree in Chemical Engineering or have completed the Master of Science program in Chemical Engineering.

Applicants need not have undertaken a master's thesis.

Applicants for the Doctor of Engineering degree must pass the doctoral qualifying examination given to applicants for the Doctor of Philosophy degree in this department.

Applicants must file application forms with the departmental graduate committee along with official transcripts of previous college work, and two letters of recommendation. Applicants will not be considered until all documents have been received. Applicants will be notified promptly as to whether or not they have been accepted.

Residence Requirement

The residence requirement is satisfied only by full-time residence for one academic year. This requirement must be fulfilled after successful completion of the qualifying examination and prior to the end of the five-year period set forth in the general regulations.

Degree Candidacy

Degree candidacy is established in accordance with the general graduate school regulations.

Qualifying Examination

The qualifying examination includes both written and oral parts and is normally given in the spring and the fall. The written examination, in general, will cover the following areas:

1. General Principles in Chemical Engineering Science
2. Thermodynamics and Stoichiometry
3. Mathematical Procedures and Kinetics
4. Specialized Technological Topics (to be announced)

The oral examination will test general comprehension.

A student may take any or all of the examinations in each area and may repeat a failed examination, only once, at a later offering. The taking and successful completion of all examinations may not extend over a period greater than 13 months. Previously administered examinations will be available to formal applicants.

Comprehensive Examination

During the time in which a student is a candidate for a doctoral degree he may be required to demonstrate by means of a comprehensive examination a subject-matter knowledge satisfactory for the award of the degree.

Course Requirements

The course requirements, in addition to the minimum requirements for establishing degree candidacy, will be determined by the departmental graduate committee and the student in consultation with the committee.

Transfer credit will be dealt with on an individual basis by the departmental graduate committee in accordance with the general graduate school regulations.

Engineering Problem

Engineering Problem advisers will be appointed by the departmental graduate committee. Approval of the topic for the Problem rests with the Problem adviser and the committee.

The Engineering Problem is not a research problem but rather an engineering problem in depth. It may include elements of design, economics, business management principles, and process development. In general, it will not include laboratory investigations.

Normally, the Engineering Problem will be solved on campus. Under special arrangements approved by the departmental graduate committee and the adviser, a portion of the work may be performed off campus.

Regardless of the arrangements made for the Engineering Problem, no off-campus adviser will be approved. Only the Problem adviser will specify the nature and requirements of the Problem, and the findings and results remain the property of the adviser and the University to be published as they determine.

Language Requirement

There is no foreign language requirement for this degree.

Computer Ability

Ability with computer programming must be demonstrated when required.

Final Oral Examination

This examination is held in accordance with the general graduate school regulations.

industrial engineering, engineering management, and information systems

The Department of Industrial Engineering offers the following degrees:
Master of Science in Industrial Engineering
Master of Science in Engineering Management
Master of Science in Information Systems
Industrial Engineer

Students pursuing a Master of Science degree may choose one of the following areas of concentration:
General Program
Assurance Sciences
Computer and Information Systems
Human Factors
Operations Research

The above programs may be taken by full-time students on a continuous basis or under the co-operative or sponsorship (intern) plans as described under the "Regulations of the Graduate School of Engineering." Students pursuing the Master of Science on a part-time basis may undertake the Engineering Management programs or may take one of the Industrial Engineering concentrations with approval by the academic adviser.

Admission

To be enrolled for graduate study leading to the degree of Master of Science in Industrial Engineering or Engineering Management, the applicant must have obtained a Bachelor of Science degree in an engineering field, with an acceptable quality of undergraduate work from a recognized college or university. A limited number of applicants with a Bachelor of Science degree in mathematics or science, whose preparation is considered adequate, may be permitted to pursue either program, and, upon its completion, qualify for the degree of Master of Science without specification. The program in Information Systems is available to students of diverse academic backgrounds.

To be accepted for candidacy for the degree of Industrial Engineer, the applicant must possess the master's degree in Industrial Engineering or equivalent from a recognized institution. Further, an applicant for candidacy must have the potential capability to structure and solve complex real-world problems. Evidence of this capability may be in the form of a thesis completed as a requirement for the Master of Science Degree, or in such other form as is acceptable to the Industrial Engineering Department Graduate Committee.

Prerequisite Courses

Entrance to any of the above programs presupposes that the student has had a basic course in each of the following areas: engineering economy, probability, engineering statistics, operations research (deterministic and stochastic), computer programming (compiler language), and accounting. Recognizing that some applicants may not have taken certain of these subjects, the program offers the intensive courses listed below. At the time of admission to the program, the adviser will specify those courses on the list which the applicant must complete satisfactorily to qualify for the degree. Such specified courses are to be completed as early in the program as scheduling will permit. The courses below carry graduate credit up to a maximum of six quarter hours of elective credit toward the degree.

Course		Credits
5.808	Basic Engineering Economy	2
5.810	Industrial Accounting for Engineers	2
5.901	Operations Research I	2
5.902	Operations Research II	2
5.913	Data Processing for Engineers (FORTRAN)	2
*5.960	Probability I	2
*5.961	Probability II	2
*5.962	Statistics I	2
		16

*(Note: As of September 1976, these courses supercede 5.950 and 5.951, Statistics I and II. Students enrolled in the program prior to this date who have not satisfied a requirement of 5.950 and 5.951 should see their adviser to work out equivalent courses and credits.)

General Requirements for the Master of Science Degree

A minimum of 40 quarter hours of graduate level credit is required for any of the Master of Science programs in the Industrial Engineering Department including not more than six quarter hours of "Prerequisite or Advanced Undergraduate Courses".

The required courses for each of the general and major area programs are listed in the following pages. The remaining hours to complete each program may be considered as free electives, unless otherwise stated. These may be any graduate courses offered within the College of Engineering or the Department of Mathematics for which the student has adequate preparation. Up to six quarter hours may be elected in other graduate schools with the approval of the student's faculty adviser and of the director of the graduate school offering the desired course. Students should consult the catalogs of the Graduate Schools of Business Administration, Arts and Sciences, or other programs. The

amount of credit applied toward the degree will be established by the student's adviser.

MASTER OF SCIENCE IN INDUSTRIAL ENGINEERING

General Program

The general program in Industrial Engineering is designed to provide an opportunity for the engineer to study contemporary industrial engineering techniques as practiced in manufacturing or service industries, or government agencies. Courses are designed to provide an environment whereby students may work with faculty members in their areas of expertise, structuring the courses in a way that enrichment in a particular specialty area can be achieved.

Students with an undergraduate degree in Industrial Engineering will have the opportunity of gaining additional expertise in the field. The engineer with a degree in another discipline can develop industrial engineering techniques, building upon his or her other particular background.

All students in the general program normally will take the core courses shown below. Equivalent substitutions must have Department approval.

Course		Credits
5.803	Industrial Organizations	2
5.823	Production Analysis (or equivalent)	4
5.824	Case Studies in Industrial Engineering (or equivalent)	2
5.909	Systems Engineering and Analysis	2
5.914	Advanced Operations Research	4
5.963	Statistics	2
5.905	Analysis with Simulation	2
5.992	Seminar (full-time students only)	2
5.991	Thesis	6
	or	
5.993	Special Project	2 or 4
		22 to 26

The remaining hours are satisfied through a suitable choice of electives from the following categories:

Management of Technology
Operations Research and Quantitative Techniques
Production Engineering and Man/Machine Systems
Financial and Operational Controls
Computer and Information Systems

Courses applicable to these areas of concentration are listed at the end of this section of the catalog. Arrangements for and approval of the topic and credit level for the special project or thesis must be made with a member of the full-time faculty of the department.

MASTER OF SCIENCE IN ENGINEERING MANAGEMENT

General Program

The Engineering Management program is designed to provide an opportunity for engineers interested in careers in managing technical types of activities to strengthen their backgrounds. Emphasis is placed on quantitative tools for problem solving and decision making as well as financial and operational controls and basic management subjects. The core course requirements for the Engineering Management program are listed below:

Course		Credits
5.801	Analysis of Independent Enterprise I	2
5.803	Industrial Organizations	2
5.816	Industrial Psychology	2
5.830	Financial Management I	2
5.841	Engineering Project Administration	2
5.905	Analysis with Simulation	2
5.963	Statistics II	2
5.941	Management Information Systems	2
5.992	Seminar (full-time students only)	2
		16–18

The remaining twenty-four hours of course work may be used to satisfy the requirements of one of the four major areas of concentration or may be elected by the student to best meet his or her professional goals.

If no major concentration is selected, at least four quarter hours of elective must come from the Operations Research and Quantitative Techniques subject area, with the remaining twenty hours taken as adviser approved electives.

MAJOR AREAS OF CONCENTRATION

Students in Industrial Engineering or in the Engineering Management Master's degree program may elect to major in one of four areas of concentration. These areas are:

1. Assurance Sciences
2. Computer and Information Systems
3. Human Factors
4. Operations Research

If a student decides to major in one of these four areas, he or she must satisfy the core requirements in the degree program and, in addition, elect courses which satisfy the requirement within the major. The requirements of each major are described below.

Assurance Sciences Major

Assurance Sciences comprise engineering and management disciplines in reliability, maintainability, quality-control, integrated logistic support, and other related engineering/manufacturing product-support activities. The assurance sciences major is aimed at the practicing engineer/manager in assurance sciences who desires to enhance his or her skills, and the engineer/manager whose activities interact with those in the field of assurance sciences who desires to develop a working knowledge of those disciplines.

The following courses are required of all students electing the Assurance Sciences major:

Course		Credits
5.954	Advanced Quality Control	2
5.955	Mathematical Theory of Reliability	2
5.956	Reliability and Maintainability Assessment	2
5.957	Reliability Analysis of Complex Systems	2
5.964	Design of Experiment I	2
5.912	Network Planning and Control	2
Courses category (B)		4
	(Operations Research and Quantitative Techniques)	16

The courses selected from Category (B) must have adviser approval to insure that a cohesive program in either quality control engineering or reliability/maintainability engineering has been followed.

Computer and Information Systems Major

The Computer and Information Systems (C&IS) major is designed to meet the needs of students desiring a concentration in the design of management information systems to support decision processes and the hardware and software concepts necessary for the implementation of such systems. The emphasis placed on each area depends on the professional objectives of the student and the programs should be developed in consultation with the adviser.

The following courses are required of all C&IS majors:

Course		Credits
Courses from category (E)		14
	(Computer and Information Systems)	14

Human Factors Major

The Human Factors major gives the opportunity for specialized preparation for the design of equipment and work places with emphasis upon occupational

safety and health and upon provision of an effective man/machine interface. All Human Factors majors will be expected to fulfill the 12 quarter hours listed below as general requirements, and further to take at least six quarter hours from the Human Factors technical electives list.

Course		Credits
5.964	Design of Experiments I	2
5.965	Design of Experiments II	2
5.819	Human Factors in Man-Machine Systems	2
5.852	Human Factors—Work and Environment	2
5.854	Human Factors Engineering—Data Base	2
5.855	Human Factors Engineering—Application Methods	2
		12
Human Factors electives (see below)		6
		18

Human Factors

5.817	Advanced Work Design	2
5.814	Development of Engineering Managers	2
5.816	Industrial Psychology of Engineers	2
5.853	Man-Computer Interaction	2
5.862	Introduction to Occupational Health and Safety	2
5.863	Technical Aspects of Health and Safety	2
5.864	Topics in Physiology and Biomedical Engineering	2
5.991	Thesis	6

Operations Research Major

The major in Operations Research is intended to provide the opportunity for extensive course work in application of quantitative techniques to the solution of problems in manufacturing or service industries. The courses are designed to provide a rigorous mathematical basis plus a focus on application of the techniques. Program flexibility is intended to permit students reasonable freedom to pursue topics most appropriate to the individual career development.

All students electing the Operations Research major are required to take:

Course	Credits
Category (B) Operations Research (must include 5.914)	14
Category (E)	4
	18

Master of Science in Information Systems

This program is intended to serve graduate students from diverse academic backgrounds. The first set of courses (totaling 24 credits) will be required of students, or waived, depending on their particular academic background and undergraduate experience. This degree is designed to offer training to professionals who will bridge the gap between the manager and the computer specialist. Graduates of this program have the opportunity to be involved in the design, development, and implementation of management information systems and decision support systems. Such systems exploit computer technology to best serve the needs of decision makers.

The program consists of courses which develop both management and information systems skills. The former category includes courses such as Organizational Behavior, Accounting, and Management Science, while the latter covers topics such as Computer Technology, Data Base Management, Operating Systems, and Software Design.

This program permits graduates to focus their skills in the information systems area, while possibly serving as a vehicle for career transition. In addition, the Master of Science in Information Systems degree program offers students the opportunity to prepare themselves for positions including application programmers, information systems analysts, data base managers, and data center managers.

Applicants who are currently employed in the information system profession may pursue the degree on a part-time or full-time basis, but all other applicants are expected to enroll as full-time students for two quarters and then participate in the graduate cooperative education program by taking a position in information systems for a minimum of six months. During this time, candidates can continue to take courses in the evening graduate program to further meet the degree requirements.

Admission

The criteria for admission will include:

1. Receipt of a bachelor's degree or equivalent from an accredited university or college.
2. Transcript from all undergraduate and graduate programs in which applicant has previously enrolled.
3. Graduate Record Examination aptitude test score.
4. Two letters of recommendation.
5. Work experience in information systems (for part-time students).

Prerequisite Courses

It is expected that students beginning this program will have an adequate background in the following areas:

calculus
probability
accounting
programming languages (including COBOL and an Assembly Language)

If students have not completed sufficient course work in any of these areas, they may enroll in the appropriate courses shown below.

Area	Course	Credits
Mathematics	10.8G1–G3 Elements of Mathematics for Information Systems I, II, and III	6
Probability	5.961, 962 Probability	4
Management Science	5.901, 902 Basic Operations Research I and II	4
Accounting	5.810,811	4
Programming Languages	5.939 Principles of COBOL	2
	5.913 Data Processing for Engineers (FORTRAN)	2
	5.930 Basic Computer Science Technology (Assembly Language)	2
		24

Based upon the recommendation of the Graduate School and the adviser, a student may be required to take all or some of the above prerequisite courses. But no more than six hours of graduate credit can be earned from these prerequisite courses.

Degree Requirements

The degree requirements are 40 quarter hours of graduate credit including:

Course	Course Title	Credits
3.972	Electronic Digital Computers I	2
3.973	Electronic Digital Computers II	2
5.803	Industrial Organizations	2
5.920	Elements of Structured Programming	2
5.933	Data Structures for Information Systems	2
5.934	Data Base Management	2
5.938	File Processing	2
5.940	Basic Information System Technology	2
5.941	Management Information Systems	2

5.942	Management Information Systems: Planning and Control of MIS Development	2
5.943	Network and Telecommunication	2
5.945	Operating Systems and Systems Software I	2
5.946	Operating Systems and Systems Software II	2
5.947	Principles of Software Design	2
5.948	Information Systems and Society	2
		30
	Electives	4–10

THE INDUSTRIAL ENGINEER DEGREE

Description

This degree is designed for those who wish to undertake graduate study beyond the master's degree which is less extensive and more applied than that required for the doctorate. The program leading to the Industrial Engineer degree permits a candidate to pursue a course of study at the upper graduate level which will develop in-depth knowledge in selected Industrial Engineering techniques, and the ability to apply these techniques to complex problems in a real-world setting. The candidate will work closely with a faculty adviser throughout the program.

Credit Requirements

A minimum of 40 quarter hours beyond the master's degree is required. Normally ten quarter hours of credit out of the 40 will be granted for work on the Industrial Engineering degree project. A minimum of 20 quarter hours must be taken in Industrial Engineering.

Industrial Engineer Degree Project

In addition to the required course work, to be awarded the degree of Industrial Engineer, the candidate must complete a project demonstrating a high level of competence in structuring and solving a complex real-world problem. The problem to be addressed in this project is of an applied nature. Where applicable, an on-going organization will be used as the setting. The work should lead to a solution which satisfies all technological and organizational constraints, and is therefore capable of being implemented. The topic will be selected by the student and the faculty adviser. Normally, a project committee of three faculty members will be appointed.

Qualifications and Examinations

A student must maintain a 3.00 grade point average to qualify for the degree. A final oral examination for defense of the written report of the Industrial Engineer degree project conducted by the student's project committee is also a requirement for the degree.

Residence Requirement

Since the Industrial Engineer degree project requires the structuring and solving of a complex problem, residence requirements will be satisfied by that arrangement, approved by the adviser, which allows the student to devote a sufficient portion of his or her time to the project to permit an intensive problem-solving experience.

COURSE LISTINGS BY SUBJECT AREA

a. Management of Technology

5.801&5.802 Analysis of the Industrial Enterprise I and II
5.803 Industrial Organizations
5.812 Managing Professional Personnel
5.813 Engineering Communication
5.814 Development of Engineering Managers
5.816 Industrial Psychology for Engineers
5.820 Personnel Administration for Engineers
5.823 Production Analysis (4 q.h.)
5.841 Engineering Project Management

b. Operations Research & Quantitative Techniques

5.903 Inventory Control and Production Planning
5.904 Queuing Theory and its Applications
5.905 Analysis with Simulation
5.906 Principles of Dynamic Systems I
5.907 Principles of Dynamic Systems II
5.909 Systems Engineering and Analysis
5.911 Linear Programming
5.912 Network Planning and Control
5.914 Advanced Operations Research (4 q.h. credit)
5.916 Engineering Analysis Utilizing Data Processing
5.918 Applied Topics in Operations Research
5.919 Independent Study in Operations Research
5.936 Simulation Methodology
5.953 Statistical Decision Theory
5.954 Advanced Quality Control
5.955 Reliability Theory in Design
5.956 Reliability and Maintainability Assessment
5.957 Reliability Analysis of Complex Systems
5.963 Statistics II
5.964 Design of Experiments I
5.965 Design of Experiments II

c. Production Engineering and Man/Machine Systems

5.806 Production Forecasting
5.817 Advanced Work Design

5.819 Human Factors–Sensory/Motor
5.822 Product Design and Value Analysis
5.823 Advanced Production Analysis (4 q.h.)
5.852 Human Factors–Work and Environment
5.853 Man Computer Interaction
5.854 Human Factors Engineering–Data Base
5.855 Human Factors Engineering–Application Methods
5.862 Introduction to Occupational Health, Safety
5.863 Technical Aspects of Health, Safety
5.903 Inventory Control and Production Planning
5.912 Network Planning and Control
5.954 Advanced Quality Control
5.956 Reliability and Maintainability Assessment

d. Financial and Operational Controls

5.805 Industrial Budgeting for Engineers
5.809 Advanced Engineering Economy
5.811 Cost Accounting for Engineers
5.830 & 5.831 Financial Management I and II
5.940 Basic Information Systems Technology
5.941 Management Information Systems

e. Computer and Information Systems

5.853 Man Computer Interaction
5.905 Analysis with Simulation
5.906, 5.907 Principles of Dynamic Systems I and II
5.916 Engineering Analysis Utilizing Data Processing
5.930 Basic Computer Systems Technology
5.931 Compiler Design I
5.932 Compiler Design II
5.933 Data Structures
5.934 Data Base Management
5.936 Simulation Methodology
5.940 Basic Information Systems Technology
5.941 Management Information Systems
5.942 Management Information Systems: MIS Planning, and Control Development
5.943 Distributed Data Processing
5.944 Computerized Financial Control Systems
3.983 Digital Computer Programming I
3.894 Digital Computer Programming II
3.895 Digital Computer III
3.9E1 Compiler Construction I-A *
3.9E2 Compiler Construction I-B *

---

* Both courses must be taken and successfully completed to receive credit.

3.972 Electronic Digital Computers I
3.973 Electronic Digital Computers II
3.974 Electronic Digital Computers III
3.985 Fundamentals of Language and Machine Theory I
3.986 Fundamentals of Language and Machine Theory II
3.987 Fundamentals of Language and Machine Theory III
3.988 Special Topics in Computer Science
3.989 Computer Peripherals

graduate program in transportation (interdisciplinary)

Admission

Individuals who have an interest in Transportation Planning and have an undergraduate degree with the appropriate mathematics background are permitted to enroll in the Interdisciplinary Transportation Program. Inquiries should be addressed to: Northeastern University Graduate School of Engineering, Interdisciplinary Transportation, 409 Churchill Hall, Boston, Massachusetts 02115.

MASTER OF SCIENCE IN TRANSPORTATION

Northeastern University has established a "Master of Science in Transportation" degree program to deal with the special needs of individuals who are preparing themselves for careers in transportation planning. The individual's program of study will aid the individual to acquire the necessary technical skills and social science background required of a transportation planner. Courses from the Colleges of Engineering, Arts and Sciences and Business Administration may be included in the student's program of study. In addition to the in-class training, a student will undertake an independent study project that results in a Master's Thesis or Master's Report. A student will work closely with an adviser on some current problem in transportation.

Full-Time Program

The program is arranged in a manner to allow a student to complete the program in one calendar year. Normally, a student will enroll in course work for three academic quarters beginning in September. The student will be eligible for graduation the following September if all course and thesis or report work is complete.

Part-Time Program

The part-time program is the same as the full-time program. The part-time student is allowed a maximum of seven years to complete all degree requirements.

Program of Study

Each student enrolled in the program is required to prepare a program of study which consists of required courses and electives in transportation and

related fields. If a student is lacking the necessary mathematics or economics background, the student must enroll in the prerequisite courses without receiving graduate credit. The program of study must consist of a minimum of forty quarter hours of credit and must be approved by the student's adviser.

Required Courses		Credits
1.807	Systems Analysis I	2
1.808	Systems Analysis II	2
1.835	Theory and Practice of Transportation Planning I	2
1.836	Theory and Practice of Transportation Planning II	2
1.916	Engineering Statistics I	2
1.917	Engineering Statistics II	2
22.847	The Politics of Transportation	3
39.9L5	Economics of Urban Transportation	3
48.801	Seminar in Intercity Transportation	3
93.820	Thesis	8
	or	
93.819	Master's Report	4

Suggested Electives		
1.207	Technology Assessment	4
1.809	Systems Analysis III	2
1.811	Urban Public Transportation	2
1.813	Traffic Flow Theory I	2
1.814	Traffic Flow Theory II	2
1.815	Urban Transportation Analysis I	2
1.816	Urban Transportation Analysis II	2
1.817	Traffic Engineering	2
1.820	Transportation Engineering	2
1.865	Environmental Impacts of Transportation I	2
1.866	Environmental Impacts of Transportation II	2
5.904	Queuing Theory	2
5.905	Analysis with Simulation	2
5.913	Data Processing (Fortran)	2
5.914	Advanced Operations Research	4
5.916	Engineering Analysis Utilizing Data Processing	2
5.941	Management Information Systems	2
22.845	Problems of Urban Administration	3
22.846	Problems of Regional Development	3
39.9K1	Regional Economics	3
39.9L1	Urban Economics I	3
22.841	Problems of Urban Planning	3
22.842	Techniques of Urban Planning	3
22.843	The Politics of Urban Planning	3
22.861	Grantsmanship	3

48.805	Urban Transportation	3
39.9L2	Urban Economics II	3
39.277	Economics of the Quality of Urban Environment and Control	4
39.9L7	Economics of Intercity Transportation	3
39.9R1	Seminar in Development Planning	3
93.818	Special Topics of Transportation	3

Prerequisites (Graduate credit approval of Program Adviser.)

BIO-ENGINEERING (INTERDISCIPLINARY)

See page 159 for course selections and descriptions.

description of courses

CIVIL ENGINEERING

The following undergraduate courses, which are given in the daytime, may be elected by graduate students for graduate credit subject to the credit hour restrictions described below. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. A maximum of eight quarter hours of credit at this level may be applied toward a Master's degree. Those civil engineering courses listed below and courses from other departments that are of an advanced undergraduate or prerequisite level are indicated by an asterisk (*) and apply to the eight quarter hour maximum regulation.

***1.207 Technology Assessment** (4 q.h. credits)
The fundamental concepts of technology assessment will be covered, including the market system, externalities, decision analysis, risk acceptance, the problems of scale, and technological monocultures. The unintended impacts of the higher-order effects of technologies will be stressed throughout the course. *Prep. Permission of instructor.*

***1.210 Legal Aspects of Civil Engineering** (4 q.h. credits)
Embodies the material in 1.832 and 1.833. Description and evaluation of the various types of contracts for engineering services and construction, procedures and formats for submitting bids, procedures for filing claims, legal steps to avoid liabilities.

***1.234 Theory and Practice of Transportation Planning** (4 q.h. credits)
Embodies the material in 1.835 and 1.836. This course includes the establishment of goals, objectives, and criteria, current planning framework, demand modeling from regional economy to transportation network assignments, mode selection, technical and economic evaluation, current issues including environmental assessment, transportation systems management, and citizen participation and planning in developing countries.

***1.259 Air Pollution** (4 q.h. credits)
Theory and practice related to engineering management of air resources, microclimate and dispersion of pollutants, atmospheric chemistry, air pollution instrumentation, control of gaseous and particulate emissions, and design of air pollution control systems. Biological and chemical aspects of air pollution with emphasis on the toxicological aspects of the environment, physiological effects of aerosols, analysis of organic and inorganic constituents of the atmosphere, and rationale for establishment of air quality criteria and standards. *Prep. Admission to Graduate School of Engineering.*

The following graduate courses carry two quarter hours of credit unless otherwise noted. Courses carrying four quarter hours of credit are day courses. Not all courses are offered every year. Refer to the Graduate School of Engineering circular issued about July 1 each year for the courses to be offered in the new academic year and the times at which they are scheduled to meet.

1.807 Systems Analysis I
Application of linear optimization models to various civil engineering problems: the simplex method, sensitivity analysis, transportation problem, transhipment problem, shortest path problem. *Prep. Admission to the Graduate School of Engineering.*

1.808 Systems Analysis II
Further application of systems analysis techniques to civil engineering problems: dynamic programming, linear regression, model estimation, queuing theory, project evaluation. *Prep. 1.807, Systems Analysis I, and 1.916, Engineering Statistics I. To be taken concurrently with 1.917, Engineering Statistics II.*

1.809 Systems Analysis III
Further application of techniques and approaches presented in 1.807 and 1.808. New topics to be presented include integer programming, nonlinear programming, simulation, decision analysis, other topics may be added according to interest, as time allows. Aim will be to help prepare students to complete a term project employing numerous techniques of systems analysis. *Prep. 1.808, Systems Analysis II.*

1.811 Urban Public Transportation
Analysis and planning of public transportation systems, including bus, subway, commuter rail, and paratransit; performance prediction; service evaluation and efficiency control measure; demand prediction; institutional and economic issues.

1.813 Traffic Flow Theory I
Statistical methods in traffic flow theory, probability models, hypothesis testing and its use, queuing theory, and simulation techniques. *Prep. Appropriate courses in calculus and statistics and permission of instructor.*

1.814 Traffic Flow Theory II
Continuation of 1.813. Deterministic methods in traffic flow theory, car following models, various methods of determination of capacity and level of service, computer applications. *Prep. 1.813, Traffic Flow Theory I.*

1.815 Urban Transportation Analysis I
Principles of analysis of urban transportation systems including travel demand equilibrium, performance and evaluation techniques using aggregate and disaggregate methods. *Prep. 1.836, Theory and Practice of Transportation Planning II, and appropriate statistics courses such as 1.916 and 1.917 or 5.961 and 5.962.*

1.816 Urban Transportation Analysis II
Continuation of 1.815. Conceptualization, formulation, application, and evaluation of mathematical models utilized in urban transportation systems analysis; case studies of representative analyses. The objective of this course is to help prepare students to conceptualize, formulate, apply, and evaluate appropriate mathematical modeling techniques in transportation. *Prep. 1.815, Urban Transportation Analysis I.*

1.817 Traffic Engineering
Measurement of traffic characteristics and system performance; theory of traffic flow and analytical techniques; systems hardware design and evaluation; current concerns in

energy, environmental, and urban amenity impacts; computer applications and institutional characteristics.

1.820 Transportation Engineering
Description and evaluation of different modes of transportation existing and proposed; their performance and cost characteristics; design, performance, and selection criteria for vehicles and roadbeds. *Prep. Admission to Graduate School of Engineering.*

1.821 Cost of Construction Projects
This course treats cost estimating, including a description of computerized cost estimating systems; duration estimating, considering work analysis techniques; value engineering as a concept and its effect on the construction industry; and specifications, including the use and importance of computerized Specification Writing Systems.

1.822 Planning and Control of Construction Activities
This course contains treatment of the application of scheduling methods to the control of construction activities including resource allocation, quality control, cash flow progress reporting, and the effects of change orders.

1.824 Engineering Materials I—Cements and Concretes
Topics covered include the chemistry, hydration, microstructure, strength, admixtures, and volume changes (shrinkage, swelling, creep) of cements and concretes. Introduction to special concretes such as underwater concrete, high-density concrete used for radiation shielding, and expansive cement concretes. *Prep. Admission to Graduate School of Engineering.*

1.825 Engineering Materials II—Strength and Microstructure of Solids
Topics covered are the elastic, inelastic, and plastic properties of solids; relation between the internal structure of solids and the corresponding mechanical properties. Application of the concepts developed. *Prep. Admission to Graduate School of Engineering.*

1.827 Construction Seminar
This course is a reading and discussion course, centering on recent research publications in Construction Engineering. *Prep. Permission of the Civil Engineering Department.*

1.830 Construction Methods and Equipment I
This course treats typical approaches to construction in a selection of application areas such as steel and concrete structures, hydraulic and port facilities, horizontal construction, and the like.

1.831 Construction Methods and Equipment II
This course is a continuation of 1.830, treating additional areas of construction.

1.832 Legal Aspects of Civil Engineering I
This course deals with the description and evaluation of various types of contracts for engineering services, bidding procedures, format and procedures for construction contract bid tender packages.

1.833 Legal Aspects of Civil Engineering II
This course deals with the description and evaluation of various types of construction contracts, procedures and formats for submitting bids, filing claims, and legal steps to avoid liabilities.

1.835 Theory and Practice of Transportation Planning I
Establishments of goals, objectives and criteria; the current planning framework; examination of performance characteristics of transportation systems, including public and private modes on land, water, and airways.

1.836 Theory and Practice of Transportation Planning II
Continuation of 1.835. Transportation demand modeling from regional economic analysis to traffic and public transportation network assignment; technical and economic evaluation; current issues, including environmental assessment, transportation systems management, citizen participation, and planning in developing countries. *Prep. 1.835, Theory and Practice of Transportation Planning I.*

1.841 Advanced Structural Mechanics I
Analysis of force equilibrium (stress), deformation/displacement (strain), and force/deformation (Hooke's law) for an elastic solid; compatibility; governing equations for complete and approximate elasticity solution. Plane stress solution for narrow rectangular beams. Torsion, Saint Venant's theory, membrane analogy, rectangular sections, thin open and closed sections. Introduction to bending of thin plates. *Prep. Undergraduate structural mechanics and structural analysis.*

1.842 Advanced Structural Mechanics II
Consistent models for the mechanics of simple structural elements: axial, bending, plane stress, and the like. Equilibrium, geometry of deformation, and force/deformation as the governing relations of all structural elements. Work and energy principles: virtual displacement, virtual forces, minimum potential energy, minimum complementary energy, introduction to variational ideas, Rayleigh-Ritz Method. *Prep. 1.841, Advanced Structural Mechanics I.*

1.843 Finite-Element Analysis of Structures I
Introduction to finite-element method for structural analysis. Overview of direct stiffness method. Formulation of element stiffness matrices by direct use of elasticity relations and by energy methods for simple elements: axial, bending, plane stress, and plane strain; transformation of coordinate systems; lumping and work equivalent loads; bounds on the error of solution. Plate bending. Use of finite-element computer programs. *Prep. 1.842, Advanced Structural Mechanics II.*

1.844 Finite-Element Analysis of Structures II
Additional applications of the finite-element method. *Prep. 1.843, Finite-Element Analysis of Structures I.*

1.847 Advanced Structural Mechanics (4 q.h. credits)
This course, offered days, embodies the material in 1.841 and 1.842, Advanced Structural Mechanics I and II. *Prep. Undergraduate structural mechanics and structural analysis.*

1.849 Model Analysis
Development of the principles of similitude to establish the relationship between behavior in the model and the full-sized structure. Review of techniques to fabricate, to load, and to instrument models. Application and use of strain gauges. The laboratory portion is devoted to model analysis of a complex structure. *Prep. Admission to program and approval of instructor.*

1.850 Seismic Design
Earthquake considerations in building design process, dynamic analysis of multi-degree-of-freedom elastic systems subjected to earthquake motions and cyclically applied forces, inelastic dynamic response analysis. Seismic provisions of building codes; soil-structure interaction. *Prep. 1.886, Soil Dynamics I.*

1.851 Selected Topics in Earthquake Engineering
Seismic hazard and seismic risk analysis; seismic design decision analysis; lifeline earthquake engineering; pipelines, liquid storage tanks, water distribution systems; earthquake analysis of earthdams and slopes; dynamic analysis of retaining walls and offshore facilities; dynamically loaded piles. *Prep. 1.886, Soil Dynamics I.*

1.853 Concrete Structures I
Fundamentals of prestressing; design of prestressed concrete beams for flexure and shear; design of end blocks; load balancing method for the analysis of indeterminate prestressed structures; column design. *Prep. Undergraduate Reinforced Concrete Design and Structural Analysis.*

1.854 Concrete Structures II
Design of two-way slabs by the equivalent frame method; shearhead design; yield line theory; prestressing of slabs; the strip method; and introduction to folded plate design. *Prep. Undergraduate Reinforced Concrete Design and Structural Analysis.*

1.855 Concrete Structures III
Additional topics of folded plate design, design of thin shelled structures inciuding hyperbolic paraboloids and shells of revolution. *Prep. 1.854 Concrete Structures II.*

1.856 Finite-Element Analysis of Structures (4 q.h. credits)
This course, offered days, embodies the course content offered in 1.843 and 1.844, Finite-Element Analysis of Structures I and II.

1.858 Concrete Structures (4 q.h. credits)
This course, offered days, embodies the material in 1.853 and 1.854, Concrete Structures I and II. *Prep. Undergraduate Reinforced Concrete Design and Structural Analysis.*

1.859 Stability
Prediction of the buckling loads of columns, behavior of beam-columns, use of numerical methods to compute the buckling loads of nonprismatic members, buckling of plates. *Prep. 1.841 and 1.842.*

1.861 Design of Structures I
An advanced course in elastic design in structural steel. Design problems involving braced and rigid frame structures subject to gravity, wind, and seismic loads are considered. *Prep. Undergraduate Steel Design and Structural Analysis.*

1.862 Design of Structures II
An advanced course in analysis and design in structural steel with emphasis on plastic behavior including rigid frame buildings and braced multistory frame buildings. *Prep. Undergraduate Steel Design and Structural Analysis.*

1.863 Design of Structures III
Advanced problems in elastic and plastic design of structural steel. Topics include curved girders, cable supported structures, fatigue considerations, and composite sections with steel deck. *Prep. Undergraduate Steel Design and Structural Analysis.*

1.864 Design of Structures (4 q.h. credits)
This course, offered days, embodies the material in 1.862 and 1.863—Design of Structures II and III. *Prep. Undergraduate Steel Design and Structural Analysis.*

1.865 Environmental Impacts of Transportation I
Examination of the human response to noise, water, and air pollution; physical effects of the pollution in relation to source-receptor configurations and urban scale meteorology; laboratory and field techniques in measuring pollution levels for air, noise, and water, and application of results to environmental impact assessment. *Prep. Admission to Graduate School of Engineering.*

1.866 Environmental Impacts of Transportation II
Continuation of 1.865. Government policy, regulations and guidelines concerning the environment and their effects on transportation planning, and preparation of appropriate documentation. *Prep. 1.865, Environmental Impacts of Transportation I.*

1.871 Soil Mechanics I
Phase relationships and index properties, permeability, capillarity, effective stress concept, porous media flow, stress distribution, stress path concept, 1-D settlement analysis. *Prep. Undergraduate course in soil mechanics.*

1.872 Soil Mechanics II
A continuation of 1.871. Consolidation theory, 3-D settlement analysis, shear strength properties of soils, stress path analysis. *Prep. 1.871, Soil Mechanics I.*

1.873 Soil Mechanics III
A continuation of 1.872. Stability of open cuts and natural slopes; numerical analysis and computer applications to stability, seepage, consolidation, and deformation problems; laboratory testing; field instrumentation; special topics. *Prep. 1.872, Soil Mechanics II.*

1.874 Foundation Engineering I
Lateral earth pressure theory; retaining wall design; anchored bulkheads; braced cofferdams, dewatering, observational approach to design. *Prep. 1.872 Soil Mechanics II.*

1.875 Foundation Engineering II
Bearing capacity, design of shallow foundations, site improvement (preloading, deep densification), case studies of foundation performance. *Prep. 1.874, Foundation Engineering I.*

1.876 Foundation Engineering III
Pile foundations, caissons, selection of foundation scheme; case studies. *Prep. 1.875, Foundation Engineering II.*

1.877 Soil Mechanics (4 q.h. credits)
This course, offered days, embodies the material in 1.871 and 1.872, Soil Mechanics I and II. *Prep. Undergraduate course in basic soil mechanics.*

1.878 Foundation Engineering (4 q.h. credits)
This course, offered days, embodies the course content offered in 1.874 and 1.875, Foundation Engineering I and II. *Prep. 1.872 Soil Mechanics II.*

1.882 Engineering Geology
Review of minerals, selected topics in historical and structural geology related to engineering geology; origin and occurrence of various rock types, geologic structures, faulting and joint systems; weathering of rock and weathering products, glaciation, geologic mapping and environmental aspects. *Prep. Undergraduate course in geology.*

1.884 Rock Mechanics I
Interrelationship with other disciplines; index properties; classification systems; laboratory tests; state of stress and stress distribution. *Prep. 1.882, Engineering Geology.*

1.885 Rock Mechanics II
Behavior of rock under combined stresses; pore pressure effects; failure theories; insite deformation modulus and shear strength characteristics; field testing. *Prep. 1.884, Rock Mechanics I.*

1.886 Soil Dynamics I
Dynamic response analysis of one-degree-of-freedom systems, characteristics of earthquakes and resulting ground motions, response spectra, stress-strain behavior of soils during dynamic and repeated loading, laboratory and field determinations, wave propagation through elastic media, effect of local soil condition upon earthquake ground motions. *Prep. Admission to the program*

1.887 Soil Dynamics II
Dynamic response analysis of a single mass, multi-degree-of-freedom systems; machine foundation design and analysis; soil-structure interaction, ground vibrations, sources, and control; shear strength during repeated loading, liquefaction; dynamic analysis of retaining structures and slopes. *Prep. 1.886 Soil Dynamics I.*

1.888 Numerical Methods in Civil Engineering I
Formulation and solution of equations for lumped parameter and continuous systems for both equilibrium and propagation problems. Solution of simultaneous equations, differential, partial differential, and integral equations are covered. Emphasis is given to finite difference solutions. Examples are drawn from structural mechanics, geotechnical engineering, hydrology and hydraulics. *Prep. Admission to Graduate School of Engineering.*

1.889 Numerical Methods in Civil Engineering II
Continuation of 1.888. Introduction of eigenvalue problems. The computer solution of large systems of equations. Introduction to Fourier series solution and the fast Fourier transform. *Prep. 1.888, Numerical Methods in Civil Engineering I.*

1.890 Numerical Methods in Civil Engineering (4 q.h. credits)
This course, offered days, combines the material of 1.888 and 1.889, Numerical Methods in Civil Engineering I and II, with emphasis on structural and geotechnical problems. *Prep. Admission to the Graduate School of Engineering.*

1.902 Open Channel Flow I
One-dimensional equation of motion, interaction of controls and surface profiles: the discharge problem, computation of surface profiles in natural and artificial channels, spatially varied flow, channel transitions. *Prep. Undergraduate fluid mechanics and hydraulic engineering.*

1.903 Open Channel Flow II
Further considerations in unsteady flow; St. Venant equations; dynamic, diffusive, and kinematic waves; flood routing in reservoirs and rivers; overhaul flow. *Prep. 1.902 and 1.888.*

1.904 Open Channel Flow (4 q.h. credits)
This course, offered days, embodies substantially the material in 1.902 and 1.903, Open Channel Flow I and II. *Prep. Undergraduate fluid mechanics, hydraulic engineering, and 1.888.*

1.908 Hydrology I
The watershed, the water balance equation and its components, unit hydrograph theory, cascade of linear reservoirs, flood routing, single deterministic rainfall-runoff models. *Prep. 1.916 and 1.917.*

1.909 Hydrology II
Markov processes and time series, stochastic generation of streamflow data, reservoir sizing, stochastic analysis of precipitation, combined stochastic deterministic simulation, flood hydrology, and design considerations. *Prep. 1.908.*

1.910 Water and Wastewater Treatment I
Water quality, water impurities and effects, the theory and practice of water treatment, and the elements of design of water treatment works including intake facilities, wells, filtration, coagulation, sedimentation, softening, iron and manganese removal, disinfection, and fluoridation. *Prep. 1.921, Environmental Chemistry II and undergraduate fluids/hydraulics.*

1.911 Water and Wastewater Treatment II
Waste characteristics, the theory and practice of wastewater treatment and disposal, and the elements of design of primary and secondary treatment works, including screening, grit removal, sedimentation, biological treatment processes, sludge digestion and disposal, stabilization ponds, and disinfection. *Prep. 1.910, Water and Wastewater Treatment I.*

1.912 Water and Wastewater Treatment III
Salt water conversion, advanced wastewater treatment, and other special problems in water and wastewater characteristics and treatment, including corrosion control, application of chemicals, radioactive wastes, thermal pollution, and treatment plant instrumentation. *Prep. 1.911, Water and Wastewater Treatment II.*

1.913 Industrial Waste Disposal
Evaluation of industrial waste problems and development of process design for the required treatment facilities; study of various manufacturing processes and their wastewater problems; industrial waste survey techniques; characteristics of industrial wastes; waste reduction methods; physical, chemical, biological, and advanced treatment methods; industrial wastewaters and disposal and treatment of industrial solids and liquids. *Prep. 1.912, Water and Wastewater Treatment III and 1.921, Environmental Chemistry II.*

1.914 Water & Wastewater Treatment (4 q.h. credits)
This course, offered days, embodies the material in 1.910 and 1.911—Water and Wastewater Treatment I and II. *Prep. Two undergraduate semesters of hydraulics.*

1.916 Engineering Statistics I
The basic elements of probability theory and statistics and their use via the solution of various civil engineering problems encountered in fluid mechanics, construction management, structures, transportation. Probability of events, random variables and distributions, derived distributions, expectation, common probability models. *Prep. Undergraduate calculus.*

1.917 Engineering Statistics II
Continuation of 1.916. Includes parameter estimation, confidence intervals, hypothesis testing, and linear statistical models. *Prep. 1.916, Engineering Statistics I.*

1.920 Environmental Chemistry I
A review of basic chemistry is followed by a discussion of the equilibrium chemistry of homogeneous and heterogeneous systems with applications in environmental engineering. The physical and chemical properties of water are studied as are acidity, alkalinity, hardness, and water softening. Topics in receiving water quality and disinfection are included. *Prep. Two quarters of general chemistry.*

1.921 Environmental Chemistry II
Continuation of 1.920. Includes the basic principles of chemical thermodynamics, electrochemistry, kinetics, organic chemistry, biochemistry, and nuclear chemistry as they relate to wastewater treatment. Colloidal chemistry and coagulation are discussed as are the fundamental water quality parameters such as BOC, COD and TOC. *Prep. 1.920, Environmental Chemistry I.*

NOTE: It is strongly recommended that 1.921 be taken concurrently with 1.930, Environmental Analysis I.

1.922 Environmental Bacteriology
A study of bacteriology with emphasis on environmental engineering applications. The course includes cell structure, nutrition, morphology, growth, reproduction, and metabolism of bacteria. Effects of environmental factors including inhibition, killing, and natural habitats are discussed. Methods of quantitative bacteriology are also covered. *Prep. 1.921, Environmental Chemistry II.*

NOTE: It is strongly recommended that 1.922 be taken concurrently with 1.931, Environmental Analysis II.

1.923 Environmental Chemistry (4 q.h. credits)
This course, offered days, embodies the material in 1.920 and 1.921—Environmental Chemistry I and II. *Prep. Two semesters of general chemistry.*

1.924 Flow Through Porous Media
Definitions, Darcy's Law, potential flow analogy and flow nets, Dupuit's approximation, study flow applications, seepage through earth dams, well hydraulics and groundwater flow. *Prep. Fluid mechanics.*

1.925 Groundwater and Seepage
Steady and transient flow in confined and unconfined aquifers, approximate (Dupuit and Boussinesq) and complete (Laplace) problem formulation, salt water intrusion. *Prep. 1.924, Flow Through Porous Media, and 1.888, Numerical Methods.*

1.930 Environmental Analysis I
A laboratory course for the analytical evaluation of environmental conditions. Included are coagulation studies, chlorine demand determination, and the use of colorimetric spectroscopy. Interpretation of analytical results for practical applications is also stressed.

NOTE: It is strongly recommended that 1.930 be taken concurrently with 1.921, Environmental Chemistry II.

1.931 Environmental Analysis II
Laboratory analyses are continued with emphasis on the chemical and biological analyses associated with wastewater treatment methods. Nitrogen determinations are included. Gas chromatography and atomic absorption spectroscopy are used for trace analyses of organics and metals. *Prep. 1.930, Environmental Analysis I.*

NOTE: It is strongly recommended that 1.931 be taken concurrently with 1.922, Environmental Bacteriology.

1.933 Environmental Analysis (4 q.h. credits)
This course, offered days, embodies the material in 1.930 and 1.931, Environmental Analysis I and II. *Prep. 1.923, Environmental Chemistry taken concurrently.*

1.935 Unit Operations in Environmental Engineering I
Laboratory scale unit operations illustrating the physical, chemical and biological principles involved in water and wastewater treatment. The aim is to obtain criteria for system design. Topics include disinfection, water softening, sedimentation, chemical coagulation, and ion exchange. *Prep. 1.931, Environmental Analysis II.*

1.936 Unit Operations in Environmental Engineering II
A continuation of 1.935. Topics include biodegradability studies using activated sludge, anaerobic digestion, vacuum filtration, and chemical-physical process involved in wastewater treatment. A comprehensive evaluation of each unit process is required in a report from each student. *Prep. 1.935, Unit Operations in Environmental Engineering I.*

1.938 Unit Operations in Environmental Engineering (4 q.h. credits)
This course, offered days, embodies the material in 1.935 and 1.936, Unit Operations in Environmental Engineering I and II. *Prep. 1.933, Environmental Analysis and 1.913, Industrial Waste Disposal.*

1.940 Public Health Engineering Survey
An historical survey of public health conditions to introduce the student to the modern approach to public health engineering problems. Applications of engineering principles to such problems as garbage and refuse disposal, control of insect-borne diseases, milk and food sanitation, rodent control, camp and recreational sanitation, housing, control of atmospheric pollution, and radiological health. *Prep. Admission to Graduate School of Engineering.*

1.945 Solid Waste Management
Basic solid waste management for engineering and science students covering storage, collection practices, sanitary landfill principles, incineration practices and reclamation possibilities. *Prep. Admission to Graduate School of Engineering.*

1.950 Air Pollution Engineering
Theory and practice related to engineering management of air resources; applications of models for the atmospheric dispersion of pollutants; analysis of control systems for gaseous and particulate emissions utilizing dry collection, wet collection, absorption, and catalytic processes. Discussion of source control evaluation and air quality standards. Course 1.957 is recommended. *Prep. Admission to Graduate School of Engineering.*

1.951 Radiological Health Engineering
Types and sources of radioactive wastes, methods of handling, storage, and disposition of solid, liquid, and gaseous radioactive wastes. Regulatory agency requirements. *Prep. Admission to Graduate School of Engineering.*

1.952 Industrial Hygiene
Characterization and control of industrial problems associated with noise, heat and ventilation. Physical and biological aspects of environmental stress are discussed. Emphasis is placed on the application of engineering principles to the design of control systems. Evaluation procedures for control effectiveness are reviewed. *Prep. Admission to Graduate School of Engineering.*

1.953 Environmental Microbiology
An advanced course in environmental microbiology. Anaerobic decomposition and eutrophication; transformations of environmental products containing compounds of sulfur, nitrogen, complex hydrocarbons and pesticides. Advanced techniques for the simulation and evaluation of microbiological systems applied to biological control of water and wastewater. *Prep. 1.922, Environmental Bacteriology.*

1.954 Stream Sanitation
Analysis of the disposal of conservative and non-conservative pollutants in streams. Topics include water quality standards, BOD and oxygen relationships in streams, bacterial pollution, eutrophication, thermal pollution, and general corrective control methods in streams. *Prep. 1.920, Environmental Chemistry I.*

1.955 Air Sampling and Analysis
A laboratory course on air pollution measurements utilizing physical, chemical, and instrumental methods and calibration and use of sampling equipment for gaseous and particulate pollutants. Identification and quantitive measurements of pollutants are per-

formed utilizing microscopy, spectrophotometry, gas chromatography, and atomic absorption spectroscopy. *Prep. 1.950, Air Pollution Engineering.*

1.956 Air Pollution Control (4 q.h. credits)
This course, offered days, embodies the material of 1.950, Air Pollution Engineering and 1.955, Air Sampling and Analysis. *Prep. Admission to Graduate School of Engineering.*

1.957 Air Pollution Science
Biological and chemical aspects of air pollution with emphasis on the toxicological aspects of the environment, physiological effects of aerosols, analysis of organic and inorganic constituents of the atmosphere and rationale for establishment of air quality criteria and standards. Note: Course 1.957 is open to non-engineering graduate students as well as engineering graduate students. *Prep. Consent of the department and instructor.*

1.963 Hydraulic Structures I
Flood studies, concrete gravity dams, earthfill dams, spillways, outlet works, hydroelectric machinery. *Prep. Undergraduate hydraulics.*

1.964 Hydraulic Structures II
Intake structures, tunnels and pipelines, canals and canal structures, shoreline protection, coffer dams. *Prep. 1.963, Hydraulic Structures I.*

1.965 Water Resources Planning
Descriptive and prescriptive models, water resources systems applications, optimization methods, simulation modelling, elements of economy, multiobjective modelling, critical path methods, river basin planning and management. *Prep. 1.909, Hydrology II.*

1.970 Design of Environmental Systems (4 q.h. credits)
The development of comprehensive engineering reports. Fundamental design concepts of complete systems for environmental control, including water treatment; wastewater disposal, air quality control, and solid waste disposal; evaluation of economic alternatives for environmental quality control; discussion of actual engineering reports and designs will include considerations of the logic and conclusions. *Prep. 1.912, Water and Wastewater Treatment III.*

1.971 Design of Environmental Systems I
The development of comprehensive engineering reports. Fundamental design concepts of complete systems, covering half the topics outlined in course 01.970. Includes evaluation of economic alternatives for environmental quality control; discussion of actual reports and designs. *Prep. 1.912 Water and Wastewater Treatment III.*

1.972 Design of Environmental Systems II
Continuation of design concepts and evaluation as offered in 1.971. Remaining topics outlined in 1.970 will be covered. *Prep. 1.971 Design of Environmental Systems I.*

1.980 Environmental Planning and Management
Planning, operation, and management of specific environmental systems, such as collection and treatment systems: solids separators, combined systems control, sewer flushing, deposition loadings with least squared applications, and case studies in optimal/

design of treatment plants with variable input. *Prep. Admission to Graduate School of Engineering.*

1.985 Environmental Protection
Environmental quality and its effects on health, comfort, aesthetics, balance of ecosystems and renewable resources; interaction of the water-land-air complex, vector control, food protection, ionizing radiation, other radiation, and the energies of heat and sound. *Prep. Admission to the Graduate School of Engineering.*

1.991 Thesis (Master's Degree) (8 q.h. credits)
Analytical and/or experimental work conducted by arrangement with and under the supervision of the department. *Prep. Permission of the Civil Engineering Department.*

1.992 Special Topics in Civil Engineering
Topics of interest to the staff member conducting this course are presented for advanced study. The course is initiated by the appropriate discipline committee and approved by the Department.

1.993 Master's Report (4 q.h. credits)
An individual effort consisting of laboratory and/or literature investigation and analysis or advanced design of a project in an area of civil engineering selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

1.994 Seminar—Environmental Engineering
Discussions by professional engineers and scientists, faculty, and graduate students on subjects in the area of environmental engineering and science. Open to day students only. *Prep. Consent of the instructor.*

1.995 Special Projects in Civil Engineering
An individual effort in an area selected by student and adviser resulting in a definitive report. *Prep. Permission of the Department.*

1.996 Seminar—Environmental Health
Discussion by professional people in the public health field, faculty, and graduate students on subjects within the area of environmental health. Open to day students only. *Prep. Consent of the instructor.*

1.997 Thesis (Ph.D. Degree)
Open to day students only. *Prep. Admission to doctoral program in Environmental Engineering.*

MECHANICAL ENGINEERING

Prerequisite courses and advanced undergraduate courses will not be given credit unless approved by an academic adviser. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. A maximum of eight quarter hours of credit at this level may be applied toward a Master's degree. The courses listed below are the Mechanical Engineering courses of an advanced undergraduate, first-year graduate level. The mechanical

engineering courses listed below and courses from other departments that are of an advanced undergraduate or prerequisite level are indicated by an asterisk (*) and apply to the eight quarter hour maximum regulation.

Course		Credits
*2.232	Engineering Materials	4
*2.233	Thermodynamics of Propulsion	4
*2.236	Nuclear Engineering I	4
*2.237	Nuclear Engineering II	4
*2.240	Combustion Engines	4
*2.258	Gas Dynamics	4
*2.260	Heat and Mass Transfer	4

The following undergraduate courses which are given in the daytime, may be elected by graduate students for graduate credit subject to the credit hour restrictions listed above.

2.232 Engineering Materials (4 q.h. credits)
Covers thermodynamics of materials; phase equilibria ternary systems; reactions with environment, i.e. kinetics, oxidation, corrosion, etc.; materials design criteria and materials engineering case studies. *Prep. Admission to the Graduate School of Engineering.*

2.233 Thermodynamics of Propulsion (4 q.h. credits)
Application of the physical principles of thermodynamics and fluid mechanics to the prediction of the behavior of propulsion devices; airbreathing engines and rocket engines with applications to show how physical laws describe and limit performance of particular devices. *Prep. Admission to the Graduate School of Engineering.*

2.236 Nuclear Engineering I (4 q.h. credits)
Study of Nuclear Physics emphasizing atomic and nuclear structure, radioactive decay, and nuclear reactions with particular attention to fusion and fission; health physics, nuclear instrumentation, and the production and uses of radio-active isotopes; comparison of thermal, fast, and breeder reactor types; discussion of neutron interactions and slowing down; four-factor formula and the diffusion equation developed and applied to one-group theory for bare and reflected thermal reactors; energy production and distribution within the core; flux shaping. Not open to students who have completed 2.942, 2.943, and 2.944. *Prep. Admission to the Graduate School of Engineering.*

2.237 Nuclear Engineering II (4 q.h. credits)
Development of two-group theory for thermal reactors; the physics and safety of fast reactors; effect of reactivity change, either intentional or accidental; changes due to temperature; fission product buildup, xenon buildup after shutdown, and fuel depletion; reactor design considerations including the interrelationship of reactor physics, reactor engineering (physical design heat transfer, etc.), reactor materials and economics; control and distribution of power; fuel cycle management. Not offered to students who have completed 2.942, 2.943, and 2.944. *Prep. Admission to the Graduate School of Engineering.*

2.258 Gas Dynamics (4 q.h. credits)
This course continues the study of fluid mechanics with emphasis on compressibility phenomena. The concept of sound speed is introduced and attention is devoted to one-

dimensional steady flows. The effects of area change, friction, and heat transfer are considered, including the study of normal shock waves and the behavior of nozzles and diffusers. *Prep. Admission to the Graduate School of Engineering.*

2.260 Heat and Mass Transfer (4 q.h. credits)
Heat exchanger design will be presented by both the logarithmic mean temperature difference (LMTD) and the effectiveness–NTU (number of transfer units) methods. This will be followed by a discussion of radiant heat transfer, the nature of solar radiation, and the design of flat plate solar collectors. *Prep. 2.150 Heat Transfer.*

The following are graduate courses which carry two quarter hours of credit unless otherwise noted. Courses carrying four quarter hours of credit are day courses. Seminar and thesis may have varying credits established by the department at the time of registration. Not all courses are offered every year. Refer to the Graduate School of Engineering circular issued about July 1 each year for the courses to be offered in the new academic year and the times at which they are scheduled to meet.

2.804 Theory of Elasticity I
Analysis of Cartesian tensors using indicial notation. Stress and strain concepts; point stress and strain; relation to tensor concepts. Governing equations for the determination of stress and displacement distributions in an elastic solid. *Prep. Admission to the Graduate School of Engineering.*

2.805 Theory of Elasticity II
Exact solutions to the governing equations; plane stress and strain problems in rectangular and polar coordinates including thermal stress; torsion of prismatic and axially symmetric bars; bending of thin flat rectangular and circular plates. *Prep. 2.801, Continuum Mechanics or 2.804, Theory of Elasticity I.*

2.806 Theory of Elasticity III
Approximate solutions for stress and displacement distributions in elastic solids; discrete solutions using finite difference and finite element methods; energy principles and the calculus of variations; relation of energy principles to the finite element method; use of energy principles to obtain approximate continuous solutions. *Prep. 2.805, Theory of Elasticity II.*

2.809 Introduction to Plasticity
Basic experimental information. Review of stress and strain tensors. Elastic stress-strain relations. Yield surface. Plastic stress-strain relations. Prandt-Reuss equations. Simple applications. *Prep. 2.804 Elasticity or equivalent.*

2.810 Advanced Mechanics of Materials I
Review of fundamental stress and deformation concepts; strain energy density; introduction to variational techniques with application to beams, frames and rings; Rayleith-Ritz method. *Prep. Admission to Graduate School of Engineering.*

2.811 Advanced Mechanics of Materials II
Beams on elastic foundation; stability analysis of beams by exact and approximate methods; bending and buckling of thin plates including use of Ritz Techniques. *Prep. 2.810.*

2.813 Advanced Mechanics of Materials III
Selected topics in solid mechanics; will vary with current interest. *Prep. 2.811.*

2.815 Plates and Shells
Bending of plates with various shapes, loads, and supports. Large deflection of plates. Membrane theory of shells. Analysis of cylindrical shells. General theory of thin elastic shells. Shells of revolution. *Prep. 2.806, Theory of Elasticity III.*

2.819 Fluid Dynamics I
The graduate sequence in fluid mechanics provides a rigorous introduction to the principles governing fluid motion. In the first course consideration is given to fluid statics, kinimatics, and mass conservation. *Prep. Undergraduate fluid mechanics or permission of the instructor.*

2.820 Fluid Dynamics II
The second course examines conservation of momentum and energy employing integral formulations and including noninertial reference frames. *Prep. 2.819, Fluid Dynamics I.*

2.821 Fluid Dynamics III
Emphasis in this course is placed upon the governing differential equations. Topics selected may include potential flows, exact solutions of viscous flows, and approximate viscous-flow solutions appropriate to low and high Reynolds numbers, respectively. *Prep. 2.820, Fluid Dynamics II.*

2.823 Advanced Gas Dynamics
The consequences of fluid compressibility are studied. Shock waves and the theory of characteristics are discussed with specific consideration given to two-dimensional steady flows and one-dimensional unsteady flows. *Prep. 2.820, Fluid Dynamics II.*

2.824 Advanced Gas Dynamics
This course continues the subject matter of 2.823. Additional topics may include axially-symmetric steady flow, small-perturbation theory, similarity rules, the hodograph method, or some aspects of physical acoustics. *Prep. 2.823, Advanced Gas Dynamics.*

2.826 Mathematical Methods for Mechanical Engineers I
Bessel and Legendre functions; boundary-value problems and series of orthogonal functions. Partial differential equations and applications to heat transfer fluid flow, vibrations and wave propagation. *Prep. Admission to Graduate School of Engineering.*

2.827 Mathematical Methods for Mechanical Engineers II
Vector analysis; divergence theorem; functions of a complex variable; Laurent series and singular points; residues and contour integration; applications. *Prep. Admission to Graduate School of Engineering.*

2.828 Mathematical Methods for Mechanical Engineers III
Matrices and linear equations. Variational calculus and applications. Approximate methods of engineering analysis. Selected topics of current interest. *Prep. 2.826 and 2.827, Mathematical Methods for Mechanical Engineers I and II.*

2.829 Engineering Fracture Mechanics III
Application of fracture mechanics to fatigue, strain energy density criteria for fracture, arrest criteria. "Work of Fracture" specimen. Application of fracture mechanics to structural analysis. Effect of anisotropy in fracture mechanics. Fracture dynamics, dynamic fracture toughness, strain rate effects. Micro-second fracture phenomenon and criteria, spall, Butcher-Tuler criterion, NAG model. Residual strength, design approaches will be emphasized. *Prep. 2.839, Engineering Fracture Mechanics II.*

2.838 Engineering Fracture Mechanics I
Fundamentals of brittle fracture; theoretical strength, micro/macro fracture characteristic, Inglis-Griffith theory, applicability of same. Linear elastic fracture mechanics; Orewan/Irwin extension to metals, effective surface tension and relation to fracture toughness, plastic zone size correction; geometry effects on fracture toughness; plane strain/plane stress fracture toughness, thickness effects. *Prep. Admission to the Graduate School of Engineering.*

2.839 Engineering Fracture Mechanics II
Experimental determination of fracture toughness; slow crack growth "popin", arrest, R-G curves, compliance techniques for determining elastic energy release note. Alternate fracture toughness concepts; resistance curve, crack opening displacement, the J integral. Application of fracture mechanics to fatigue. Design methods to minimize risks of catastrophic failure will be emphasized. *Prep. 2.838, Engineering Fracture Mechanics I.*

2.840 Finite Element Analysis
Introduction to the finite element method. Variational formulations; simple interpolation functions and element stiffness matrices. Triangular and rectangular elements. Assembly technique and constraining of resulting equations. Elementary applications. *Prep. 2.826 and 2.827 or permission of instructor.*

2.841 Vibration Theory and Applications
Modeling of vibratory systems; one-degree-of-freedom systems (determination of equations of motion using free-body and energy methods); forced and free vibrations through two degrees of freedom; Laplace transformation techniques; phase-plane diagrams for undamped forced vibrations and Coulomb damping. *Prep. Admission to the Graduate School of Engineering.*

2.842 Vibration Theory and Applications
Multiple degrees of freedom; free and forced vibrations with or without damping, extensional and torsional oscillation, frequency equation, energy methods of solution. *Prep. 2.841, Vibration Theory and Applications or 2.861, Systems Engineering.*

2.843 Vibration Theory and Applications
Systems with distributed mass and stiffness; shock and impact; vibrations of beams and related structures; nonlinear and random vibrations. *Prep. 2.842, Vibration Theory and Applications.*

2.845 Shock, Vibration, and Noise Control
Theoretical and practical considerations pertinent to the design and protection of structures and equipment subject to severe environments of transient shock, steady state

vibration, random vibration, and acoustic noise. *Prep. 2.843, Vibration Theory and Applications.*

2.846 Nonlinear Vibrations
Studies of various nonlinear problems and the techniques used in solving them. Symmetrical and unsymmetrical systems. The Van der Pol-Kryloff-Bogoliuboff method as well as others will be discussed. *Prep. 2.843, Vibration Theory and Applications.*

2.847 Dynamics I
Application of fundamental laws of motion. Transformations of coordinate systems, kinematics of a particle using translating or rotating axis, LaGrange equations, space dynamics. *Prep. Admission to the Graduate School of Engineering.* See course 2.270.

2.848 Dynamics II
Dynamics of rigid bodies, moments of inertia in three dimensions, Euler's Equations, includes gyroscopic motion. *Prep. 2.847, Dynamics I.* See course 2.270.

2.849 Automatic Control Engineering
Concepts of feedback control; formulation of equations, transfer functions, and block diagrams representing components and systems; linearization; Laplace transformation; stability. *Prep. Admission to the Graduate School of Engineering.*

2.850 Automatic Control Engineering
Study of control action; analysis and design by use of root-locus and frequency-domain techniques. *Prep. 2.849, Automatic Control Engineering.*

2.851 Automatic Control Engineering
Further consideration of linear systems including compensation methods and multiple-inputs. Techniques for the treatment of non-linear systems. *Prep. 2.850, Automatic Control Engineering.*

2.853 Fundamentals of Instrumentation
Theoretical principles underlying the design and operation of instruments for measurement and/or control. Analysis of stimulus-response relations. Industrial instruments for measurement and control, including those based on pneumatic and electrical systems. *Prep. Bachelor of Science degree.*

2.854 Industrial Process Control
Fundamental principles involved in automatic control of industrial processes. Economic considerations. Application of control instruments to obtain automatic control of temperature, pressure, fluid flow, liquid level, humidity, pH. *Prep. 2.853, Fundamentals of Instrumentation.*

2.855 Solar Thermal Engineering I
A model is developed for the hourly direct and diffuse radiation under a cover of scattered clouds and the transmission and absorption of this radiation by passive and active systems. The design of air heating systems and the storage of the collected energy by a pebble-bed are considered, as well as elements of heat exchanger design. A study of the economics of a domestic water and/or space heating system is made using f-chart analysis. *Prep. 4.862, Solar Energy Thermal Processes or equivalent background.*

2.856 Solar Thermal Engineering II
The design and analysis of several solar thermal systems are considered, such as: LiBr-H_2O absorption cooling units, heat pumps, compound parabolic collectors, and the heat pipe type of solar collector. *Prep. 2.855, Solar Thermal Engineering I.*

2.901 Advanced Thermodynamics
A critical examination of equilibrium thermodynamics from a rigorous viewpoint emphasizing fundamental concepts including: equilibrium, heat, and work; the first and second law of thermodynamics; energy; heat engines, simple systems, and open systems. *Prep. Admission to the Graduate School of Engineering.*

2.902 Advanced Thermodynamics
Continuation of 2.901 including: examination of temperature scales; entropy and availability; the phase rule, single component systems; thermodynamic relations. Consideration is also given to the ideal gas; chemical potential and thermodynamics of ideal gas mixtures. *Prep. 2.901, Advanced Thermodynamics.*

2.903 Advanced Thermodynamics (4 q.h. credits)
Embodies the material in 2.901 and 2.902 Advanced Thermodynamics. *Prep. Admission to the Graduate School of Engineering.*

2.904 Special Topics in Advanced Thermodynamics
Topics to be considered may vary from year to year depending on the interests of the instructor. Particular emphasis will be placed on the statistical approach in thermodynamics with topics chosen from: (i) equilibrium statistical mechanics; ensemble theory, partition functions, classical and quantum ideal gases, or (ii) kinetic theory of gases; simple kinetic theory, mean free path, transport phenomena, distribution functions, the Boltzmann equation, H-theorem, Chapman-Enskog expansion. *Prep. 2.902 or 2.903 and 2.826.*

2.905 Cryogenic Engineering
Designed to provide a familiarity with the general field of cryogenics, some of the principal uses of cryogenics, and the ways of obtaining and preserving an environment at a low temperature. Refrigeration, cycle analysis, heat exchanger design, insulation systems, properties of materials, instrumentation problems and applications. Problems will be assigned typical of those which are encountered in the field and laboratory. *Prep. Admission to the Graduate School of Engineering.*

2.906 Cryogenic Engineering
Continuation of 2.905, Cryogenic Engineering. *Prep. 2.905, Cryogenic Engineering.*

2.907 Cryogenic Engineering
Application of Cryogenic Engineering Principles to the design of integrated systems. *Prep. 2.906, Cryogenic Engineering.*

2.910 Conduction Heat Transfer
The course topics are analytical solution methods for multidimensional systems in steady-state and transient conditions and an introduction to finite-difference numerical analysis. *Prep. Undergraduate course in heat transfer, or consent of instructor.*

2.911 Convection Heat Transfer
The course topics are analytical and approximate integral solution methods to convection heat transfer problems. Internal and external flow problems are discussed for both laminar and turbulent flow conditions. *Prep. Undergraduate course in heat transfer and fluid dynamics, or consent of instructor.*

2.913 Radiation Heat Transfer
The course topics are the laws of thermal radiation and solution methods to radiative transfer between gray diffuse and gray specular surfaces. The problems of radiative transfer with conduction and convection heat transfer are discussed. *Prep. Undergraduate course in heat transfer.*

2.920 Direct Energy Conversion
The fundamental processes of direct energy conversion and their application to the design and operation of magnetohydrodynamic power generators, thermionic converters, and fuel cells. *Prep. Admission to the Graduate School of Engineering.*

2.921 Direct Energy Conversion
Continuation of 2.920. *Prep. 2.920, Direct Energy Conversion.*

2.923 Special Topics in Direct Energy Conversion
Irreversible thermodynamics. Unified theory of energy conversion. *Prep. 2.921, Direct Energy Conversion.*

2.930 Pumps
Deals mainly with centrifugal pumps, with brief references to other types; flow of fluids in pipes and conduits, system curves, pump head velocity diagrams and head development, efficiency; specific speed, net positive suction head, cavitation; affinity laws, selection of pumps to suit various operating conditions and methods of driving, parallel operation; automatic operation, types of construction and materials used, methods of priming centrifugal pumps, pumping of chemicals, oils, and sludges, special problems of pump installation and operation, water hammer in pump discharge lines. *Prep. Hydraulics.*

2.931 Fans and Blowers
Flow of air in pipes and ducts, fan characteristics and laws, various types of fan wheels, inlet and outlet connections, fan capacity control, fan selection and testing. Compression of air and gases, flow in pipes, head-on blowers, performance curves, effect of changes in speed and inlet conditions, construction, regulation, selection, installation, and testing. Axial flow fans and blowers. Positive pressure blowers. *Prep. Thermodynamics.*

2.935 Power Plant Design
Study of the thermodynamic cycles, equipment, and processes of the various types of power plants, with emphasis on modern central station practice. *Prep. Thermodynamics.*

2.936 Power Plant Design
Continuation of 2.935, Power Plant Design. *Prep. 2.935.*

2.938 Power Generation Economics
Integrated study of the various factors affecting cost of power generation, including the effects of fuels availability and pricing, equipment selection and plant efficiency, siting and financial considerations. *Prep. 2.935.*

2.942 Nuclear Engineering I
Topics include: growth of nuclear power industry; study of nuclear physics emphasizing atomic and nuclear structure, radioactive decay, and nuclear reactions with particular attention to fission and fusion; radiation health physics; principles of shielding; nuclear instrumentation; production and application of radioisotopes; neutron interactions and slowing down theory: neutron activation analysis. (Not open to students who have completed 2.236 & 2.237.) *Prep. Admission to Graduate School of Engineering.*

2.943 Nuclear Engineering II
Comparison of thermal, fast, and breeder reactors; four factor formula and the neutron diffusion equation; one-group, modified one-group, two-group and multi-group theory; bare and reflected thermal reactors; energy production and distribution within core; flux shaping; transient reactor behavior and control; factors affecting reactivity including temperature, pressure, void formation, fission product accumulation, fuel depletion and fuel breeding; Xenon buildup after shutdown. (Not open to students who have completed 2.236 & 2.237.) *Prep. 2.942.*

2.944 Nuclear Engineering III
Reactor design considerations; interrelationship of reactor physics, control, engineering, materials, safety, and fuel cycle management; reactor types; radiation damage and reactor materials; nuclear fuels; reactor heat transfer; economics of nuclear power; environmental effects. (Not open to students who have completed 2.236 & 2.237.) *Prep. 2.943.*

2.953 Advanced Physical Metallurgy III
The kinetics of phase transformations in metals. Topics include kinetic theory, empirical kinetics, diffusion in metals, nucleation, diffusional growth, martensitic transformations. *Prep. A recent introductory material science course.*

2.954 Advanced Physical Metallurgy I
Dislocation theory; including such topics as dislocation stress fields, self-energy, velocity, interactions mechanisms, image forces, and theories of yielding. *Prep. A recent introductory material science course.*

2.956 Advanced Physical Metallurgy II
Mechanical behavior of metals. Application of dislocation theory to micro-plasticity, strain hardening, strengthening mechanisms and creep. *Prep. 2.954, Advanced Physical Metallurgy I.*

2.958 The Structure and Properties of Polymeric Materials I
Introduction to the organic chemistry of polymers, effect of chemical composition on structure, melting point and glass transition temperature, polymer characterization and degradation, thermodynamics of polymers. *Prep. Undergraduate material science course.*

2.959 The Structure and Properties of Polymeric Materials II
Rheology and mechanical behavior of polymers, analysis and testing, effects of processing on structure and physical properties, industrial polymers, resin base composites. *Prep. 2.958*

2.960 Thermodynamics of Materials I
Basic metallurgical thermodynamics encompassing first, second, and third laws, entropy, enthalpy, and free energy. *Prep. Engineering Materials.*

2.961 Thermodynamics of Materials II
Continuation of 2.960 with emphasis on solutions, activity, activity coefficients, the phase rule and applications to some metallurgical problems. *Prep. 2.960, Thermodynamics of Materials I.*

2.963 Thermodynamics of Materials III
The application of metallurgical thermodynamics to various process metallurgical problems, i.e., gas-solid systems, etc., plus kinetics of reactions and dynamics systems analysis. *Prep. 2.960 or 2.961, Thermodynamics of Materials I or II.*

2.965 Physical Ceramics
Introduction to ceramic fabrication processes. Characteristic of vitreous and crystalline solids, structural imperfections, and atomic mobility. Phase equilibria, nucleation, crystal growth, solid-state reactions, non-equilibrium phases, and effects on the resulting microstructure of ceramics. *Prep. A recent introductory material science course, Physical Chemistry or Solid State Physics.*

2.966 Physical Ceramics
Discussion of effects of composition and microstructure on the thermal, mechanical, optical, electrical, and magnetic properties of ceramic materials. *Prep. 2.965, Physical Ceramics.*

2.970 Material Science and Engineering I
Principles underlying the structure and properties of solid materials. The relationships of these principles to the properties and to applications in structures and devices. Both macroscopic-phenomenological and electronic-molecular approaches will be used. Materials will include metals and alloys, semiconductors, and dielectrics. Typical subjects are atomic and electronic structures, ordering, nucleation, crystal growth, and thermal properties. *Prep. A recent introductory materials science course.*

2.971 Material Science and Engineering II
Continuation of 2.970 into additional topics such as thermal, electric, magnetic, and optical properties; applications of solid-state phenomena to achieve functions embodied in transducers, filters, amplifiers, energy converters, and so forth. *Prep. 2.970, Materials Science and Engineering I.*

2.972 Materials Science and Engineering III
Continuation of 2.971 plus a discussion of various special topics that will vary from year to year. Examples are: metastable phases and thin films. *Prep. 2.971, Materials Science and Engineering II.*

2.975 Introduction to Diffraction Methods in Materials Science
General principles of the diffraction of short wave length radiations; such as x-ray, electrons, and thermal neutrons by materials are studied with emphasis on the understanding of the similarities and differences of the different radiations when applied to the study of

the structures of crystalline and non-crystalline materials. *Prep. A recent introductory material science course.*

2.976 Diffraction Methods in Materials Science
Continuation of 2.975 with emphasis on the experimental methods and applications. This includes: choice of radiation, introduction to instrumentation, sample preparation, methods of detection and recording of the diffracted radiation, analysis, interpretation and use of the results. *Prep. 2.975, Introduction to Diffraction Methods in Materials Science.*

2.985 Powder Metallurgy
Powder characteristics and methods of manufacture. Powder pressing: packing, interparticle bonding, effects of pressure. Principles of sintering. Characteristics and properties of products made from powdered materials. *Prep. A recent introductory material science course.*

2.990 Mechanical Engineering Seminar I (1 q.h. credit)
Introduce first year graduate students to graduate research and the mechanics of undertaking a Master's thesis; research opportunities in the various mechanical engineering disciplines; interdisciplinary research opportunities; definition of a research problem; the role of a thesis adviser; methods of conducting research; writing a Master's thesis. *Prep. Admission to Master of Science Program.*

2.991 Thesis (Master's Degree)
Analytical and/or experimental work conducted under the auspices of the department. Open to day students only. *Prep. Admission to Master of Science Program.*

2.992 Special Problems in Mechanical Engineering
Theoretical or experimental work under individual faculty supervision. *Prep. Consent of department chairman.*

2.993 Special Topics in Mechanical Engineering
Topics of interest to the staff member conducting this class are presented for advanced study. *Prep. Permission of department staff.*

2.994 Doctoral Reading
Material approved by the candidate's adviser (only S or F grades will be assigned for this course). *Prep. Passing of Ph.D. Qualifying Exam.*

2.995 Dissertation (Ph.D. Degree)
Theoretical and experimental work conducted under the supervision of the department. Open to day students only. *Prep. Admission to the Doctoral Program in Mechanical Engineering.*

2.996 Dissertation (Mechanical Engineer Degree)
Analytical and/or experimental work conducted under the auspices of the department. Open to day students only. *Prep. Admission to the Mechanical Engineer Degree Program.*

2.998 Mechanical Engineering Seminar II
Graduate students in their final Master's year will present current results of their thesis work. Non-thesis students will present reports on scientific work that they have pursued

in the past or have studied in technical literature. *Prep. 2.990, Mechanical Engineering Seminar I.*

ELECTRICAL ENGINEERING

Prerequisite courses and advanced undergraduate courses will not be given credit unless approved by an academic adviser. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. A maximum of four quarter hours of credit at this level may be applied toward a Master's degree. All electrical engineering courses listed below and courses from other departments that are of an advanced undergraduate or prerequisite level are indicated by an asterisk (*) and apply to the four quarter hour maximum regulation.

3.800 Plasma Engineering
Behavior, diagnostics, and generation of plasma and gas discharges; emphasis on the engineering and experimental point of view rather than on a rigorous theoretical treatment. Current literature on a variety of plasma engineering applications will be introduced throughout the course. First quarter topics include: dynamics of charged particles in static electric and magnetic fields, E and M wave-plasma interactions, Infinite and Finite Media, elastic and inelastic collisions. *Prep. Bachelor of Science degree in Electrical Engineering or Physics or 3.977, Precis of Modern Electrical Engineering III.*

3.801 Plasma Theory I
Plasma electrodynamics and linear response theory. Fluid and Vlasov descriptions of plasmas with and without magnetic fields. Dispersion and damping of collective modes. Beam-plasma linear instabilities and application to shock wave structures. *Prep. 3.876 Electromagnetic Theory II*

3.802 Plasma Theory II
Plasma electrodynamics and nonlinear response theory. Fluctuation-Dissipation theorems. Sum rules. New approaches to strongly correlated plasmas: equation of state, liquid-solid phase-transitions, dispersion and damping of collective modes. Role of strongly correlated plasmas in laser- and heavy particle beam-inertial confinement schemes in thermonuclear fusion. *Prep. 3.801 Plasma Theory I.*

3.803 Plasma Theory (4 q.h. credits)
Offered days. Includes the material given in 3.800 and 3.801 — Plasma Engineering and Plasma Theory I. *Prep. Bachelor of Science degree in Electrical Engineering or Physics or 3.977, Precis of Modern Electrical Engineering III.*

3.806 Lasers I
Review of basic optical principles and atomic physics; introduction to optical coherence; models for the interaction of electromagnetic radiation with matter; a general description of lasers is given. *Prep. Bachelor of Science degree in Engineering or Science.*

3.807 Lasers II
Laser threshold and rate equations; elementary resonator theory and fabrication; giant pulse operation; specific solid-state, liquid, and gas lasers; and laser systems. *Prep. 3.806, Lasers I.*

3.808 Laser Applications
Applications of lasers and laser systems for a variety of engineering and basic science disciplines; specific laser optoelectronic devices. *Prep. 3.807, Lasers II or equivalent.*

3.810 Thermonuclear Fusion Energetics I
Application of the concepts developed in 3.800 and 3.801 to the problem of thermonuclear plasmas. Emphasis will be on magnetic confinement schemes. Both open (mirror machines) and closed (torroidal confinement machines) systems will be discussed. *Prep. 3.801, Plasma Theory I.*

3.811 Thermonuclear Fusion Energetics II
Continuation of magnetic confinement schemes. Trapped particle instabilities and anomolous transport effects will be discussed. Introduction to interfial confinement (laser fusion). *Prep. 3.810, Thermonuclear Fusion Energetics I.*

3.812 Thermonuclear Fusion Energetics III
Introduction to Microinstabilities associated with laser fusion devices. Introduction to computer modeling of plasmas. Discussion of recent advances in thermonuclear plasma generation by relativistic electron beams. *Prep. 3.802, Plasma Theory II; 3.811, Thermonuclear Fusion Energetics II.*

3.817 Acoustics I
Radiation, transmission, and absorption phenomena of plane, spherical, and cylindrical waves. Distributed system analogies with digital computer solutions for complex systems. *Prep. Bachelor of Science degree in Engineering.*

3.818 Acoustics II
Sound system engineering, including loudspeakers, microphones, and acoustic measurements. Environmental acoustics, including speech, hearing, noise, and room acoustics. *Prep. 3.817.*

3.819 Acoustics III
Ray acoustics. Ultrasonic and sonar transducers. Properties of transducer arrays. Underwater radiation, transmission, and absorption phenomena. *Prep. 3.818*

3.823 Mathematical Methods in Electrical Engineering (4 q.h. credits)
This course, offered days, includes the material in 3.8C4 and 3.8C5, Mathematical Methods in Electrical Engineering III and IV. *Prep. Bachelor of Science degree in Engineering.*

3.824 Linear Systems Analysis I
A study of the basic concepts of linear systems from the functional viewpoint. The time domain and transform techniques of analysis and their application to the study of filters and feedback systems. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.*

3.825 Linear Systems Analysis II
Introduction to the state variable theory of continuous and discrete linear systems. Standard canonical representations. The concept of state and the representation of interconnected systems. Linear spaces. The state equations and their solution. Stability. Introduction to the general control problem in terms of controllability and observability. *Prep. 3.824 or equivalent.*

3.826 Linear Systems Analysis III
A continuation of 3.825. *Prep. 3.825, Linear Systems Analysis II.*

3.827 Linear Systems Analysis (4 q.h. credits)
Offered days. Includes the material given in 3.825 and 3.826, Linear Systems Analysis II and III. *Prep. Bachelor of Science degree in Electrical Engineering and 3.824, Linear Systems Analysis I or equivalent.*

3.830 Network Synthesis I-A *
Matrix circuit analysis including m-port parameter systems. Positive-real functions. Energy functions. Driving-point synthesis techniques for LC, RC, and RL networks. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, Precis of Modern Electrical Engineering I.*

3.831 Network Synthesis I-B *
Driving-point synthesis of RLC networks. Properties of two-port networks. Two-port synthesis, including the parallel ladder realization. Lattice synthesis. *Prep. 3.830, Network Synthesis I-A.*

3.832 Network Synthesis I (4 q.h. credits)
Offered days. Includes the material given in 3.830, Network Synthesis I-A and 3.831, Network Synthesis I-B. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, Precis of Modern Electrical Engineering I.*

3.833 Network Synthesis II
Scattering, immittance, and hybrid formalisms for linear networks; state-space formulation and techniques for time-invariant and time-varying networks; introduction to passive n-port synthesis. *Prep. 3.831, Network Synthesis I-B or 3.832, Network Synthesis I.*

3.837 Graph Theory
Fundamentals of graph theory, including blocks, trees, connectivity, partitions, traversability, line graphs, factorization, coverings, planarity, matrices, digraphs, and enumeration problems. Selected applications of graph theory in such fields as network theory, switching theory, and computer science. *Prep. Bachelor of Science degree in Engineering or Science.*

3.838 Nonlinear Circuit Analysis I
Numerical, graphical, and analytical methods for the solution of physical systems described by nonlinear differential equations. Geometric analysis in second-order systems.

---

* Both A & B courses must be successfully completed to receive credit.

Perturbation and averaging theory. *Prep. 3.831, Network Synthesis I-B or 3.832, Network Synthesis I.*

3.839 Nonlinear Circuit Analysis II
Linear, time-varying systems and their relationship to certain nonlinear problems. The WJKB approximation. The Hill and Mathieu Equations. Stability of nonlinear systems. Lyapunov Theory. Selected topics in nonlinear analysis according to group interest. *Prep. 3.838, Nonlinear Circuit Analysis I.*

3.840 Linear Active Circuits I
Active compound circuits with emphasis on IC circuit topologies are developed as an extension of known discrete active device characteristics. Use is made of modern circuit theory techniques, including glowgraphs, matrices, Blackman's formulation for feedback and frequency response in terms of natural frequencies to determine compound circuit limitations. Models of IC operational amplifiers, instrumentation amplifiers, voltage comparators, and the like are developed and analyzed. Advantages and limitations of these IC active circuits are investigated. *Prep. Bachelor of Science degree in Electrical Engineering or 3.976, Precis of Modern Electrical Engineering II.*

3.841 Linear Active Circuits II
The topics of 3.840 are continued with emphasis on IC operational amplifiers, advantages and limitations including dynamic range, overload characteristics, and slow rate. Gain-bandwidth and speed characteristics are investigated for large and small signal conditions. Feedback, stability, and compensation in closed-loop systems and effects of feedback on impedance levels are explored. Applications for analog signal processing and conditioning, i.e. active filter design, summing, integration and coefficient amplifiers are investigated. Limitations caused by shot and thermal noise, definition of noise figure, and noise models are taken up. *Prep. 3.840, Linear Active Circuits I.*

3.842 Linear Active Circuits (4 q.h. credits)
Offered days. Includes all the material given in 3.840 and 3.841 Linear Active Circuits I and II, plus additional topics as time permits. *Prep. Bachelor of Science degree in Electrical Engineering.*

3.843 Linear Active Circuits III
A continuation of the material covered in Linear Active Circuits I and II. Emphasis will be placed on feedback systems, including multiloop amplifier design. These techniques will be applied to integrated circuit realizations of basic active networks. *Prep. 3.840, Linear Active Circuits I or 3.841, Linear Active Circuits II.*

3.845 Active Network Synthesis
Basic methods of active network synthesis are introduced through three commonly used approaches: feedback amplifier, negative impedance convertor, and gyrator; structures of Sallen and Key, Kuh, Linvill, Yanagisawa, Rohrer, Kinariwals, Sepress, and Calahan; consideration of the practical realization of NIC's and gyrators, standard decomposition methods and sensitivity; work of Sandberg, Larky, Newcomb, Daniels, Horowitz, and Thomas. *Prep. 3.831, Network Synthesis I-B and 3.841, Linear Active Circuits II or equivalent.*

3.853 Solid State Device Theory and Practice (4 q.h. credits)
This course meets twice weekly. On one night there is a two-hour lecture; on the other, a three-hour lab. The course carries four quarter hours of credit.
A case method study of solid state devices with a laboratory tightly integrated with the classroom work. The methodology developed is fundamental to the discrete and integrated circuit technology. The classroom portion of the course is devoted to junction diode and bipolar transistor theory including the physics of achieving a given design. In the laboratory, the student designs, builds, and tests diodes and transistors to meet certain electrical characteristics. The devices achieved are seldom of commercial quality, but sufficient equipment is available in the laboratory to make practical device processing possible even for completely untrained personnel. *Prep. An undergraduate level background in electronics and semiconductor devices.*

3.854 Solid State Theory and Practice (4 q.h. credits)
The course is offered on the same basis as 3.853 and is a continuation of that course. The central topic is field effect transistors with appropriate design problems for the laboratory. *Prep. 3.853, Solid State Device Theory and Practice.*

3.8G1 Characteristics and Models of Solid State Devices I
This sequence of three courses is designed to develop real insight into the operation of a broad range of semiconductor devices. Important topics in the physics of semiconductors to provide the background necessary for device analysis are discussed. Analysis of fundamental building-block units of which devices are made including the PN junction, the ohmic contact and the Schottky barrier. Each is examined under reasonable extremes of bias and temperature to establish the electrical behavior expected from such elementary units. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.*

3.8G2 Characteristics and Models of Solid State Devices II
Detailed analysis of the bipolar transistor, metal-oxide-semiconductor interface, its influence on the behavior of real junctions, and the various realizations of the field-effect transistor. *Prep. 3.8G1, Characteristics and Models of Solid State Devices I.*

3.8G3 Characteristics and Models of Solid State Devices III
A continuation of the work of the previous two courses. A detailed analysis of the performance of FET's will permit a critical comparison of field effect and bipolar transistors. Solid state microwave devices; devices that are both unique to microwave applications and the relevant low-frequency elements which require somewhat different analysis at microwave frequencies. An examination of noise in semiconductor devices. *Prep. 3.8G2, Characteristics and Models of Solid State Devices II.*

3.860 Pulse Processing I
The principles and techniques of pulse-forming and pulse-processing circuits will be developed. Pulse forming, switching and time base generators will be covered.
Prep. Bachelor of Science degree in Electrical Engineering or 3.975, 3.976, and 3.977, Precis of Modern Electrical Engineering I, II, and III.

3.861 Pulse Processing II
Continuation of 3.860, Pulse Processing I, to include the pulse processing circuits and the analog/digital interface techniques in radar, digital computation and data processing systems. *Prep. 3.860, Pulse Processing I.*

3.865 Radar Systems I
Emphasis on the systems aspects of radar engineering. Topics covered include basic theory of radar detection, measurement of range, angle, and Doppler shift; classes of radar systems; types of radar noise; components of a radar system; matched filters and correlation receivers as applied to radar systems; fundamental ideas of radar system analysis. *Prep. 3.901, Applied Probability and Stochastic Process II or 3.902, Applied Probability and Stochastic Processes.*

3.866 Radar Systems II
Continuation of 3.865, Radar Systems I. In-depth study of search radar theory; maximum likelihood estimation approach to measurement of radar target parameters; resolution and ambiguity functions applied to radar; radar parameter uncertainty principles. *Prep. 3.865, Radar Systems I.*

3.867 Radar Systems III
Advanced topics in radar systems engineering. Topics to be covered will be dictated somewhat by student interest and level of preparation. These may include, for example, design considerations for multistatic radar systems synthetic aperture radars; tracking systems; radar waveform synthesis; multifunction array radar techniques and selected topics in radar sensing techniques and devices. *Prep. 3.865, Radar Systems I, and 3.866, Radar Systems II.*

3.871 Communications Systems I
Primarily concerned with radio communication systems as used in terrestrial and space communication applications. Antenna gain, space loss, cosmic and atmospheric noise, and receiver noise as factors influencing the signal-to-noise ratio in space and satellite repeater systems; channel models are developed for over the horizon systems utilizing ionospheric propagation and exhibiting fading and multipaths; contemporary systems are discussed from the standpoint of signal spectrum, noise power and message ambiguity as exhibited at the output of the intermediate frequency receiver. *Prep. Background in probability and Fourier analysis.*

3.872 Communications Systems II
Primarily concerned with the theoretical aspects of analogue modulation systems used in radio and space communications. First and second threshold effects will be discussed in conjunction with signal-to-noise considerations for amplitude and angle modulated systems. Treatment of frequency feedback and phase-lock loops will be included in the discussion of frequency modulation and detection. Frequency division multiplexing will include sub-carrier pre-emphasis and comparative performance figures for SSSC/FM and FM/FM. *Prep. 3.871, Communications Systems I or 3.900, Applied Probability and Stochastic Processes I.*

3.873 Communications Systems III
Continuation of techniques of 3.872 to cover digital modulation systems and time division multiplexing. Adaptive sampling, aliasing, and interpolation will be discussed along with PAM/FM. Pulse code modulation systems utilizing frequency and phase shifted carriers will be compared under noise conditions. Treatment will be given to the use of codes with special correlation, modulation by sequences, and phase-coherent communication. *Prep. 3.872, Communications Systems II.*

3.875 Electromagnetic Theory I
Maxwell's equations and related electromagnetic laws and relations; basic properties of matter; electromagnetic potentials; the scalar and vector Poisson, D'Alembert, and Helmholtz equations; Green's functions; both mathematical and physical aspects of the theory and their relation to engineering applications. *Prep. Bachelor of Science degree in Electrical Engineering or 3.977, Precis of Modern Electrical Engineering III, Advanced Calculus, and Vector Analysis.*

3.876 Electromagnetic Theory II
Basic radiation phenomenon including retarded potentials, radiation from moving charges, electromagnetic energy, and energy-related theorems. Propagation of plane waves in media with real and complex constitutive parameters. Fundamental theory of guided waves. *Prep. 3.875, Electromagnetic Theory I.*

3.877 Electromagnetic Theory (4 q.h. credits)
Offered days. Includes the material given in 3.875 and 3.876, Electromagnetic Theory I and II. *Prep. Bachelor of Science degree in Electrical Engineering or 3.977, Precis of Modern Electrical Engineering III.*

3.878 Advanced Electromagnetic Theory I
More advanced approaches to problems in electromagnetic theory of interest to electrical engineers — for example: waveguide, antennas, diffraction, and scattering; approximation techniques for obtaining useful solutions of field theory problems including integral equation, perturbation, and variational techniques. *Prep. 3.876, Electromagnetic Theory II or 3.877, Electromagnetic Theory.*

3.879 Advanced Electromagnetic Theory II
Special relativity and relativistic electrodynamics. Radiation from moving charges. Statistical concepts and propagation in random media. Introduction to magnetohydrodynamics and plasma physics. *Prep. 3.878, Advanced Electromagnetic Theory I.*

3.880 Microwave Engineering Principles I
Review of electromagnetic theory concepts directly applicable to analysis of microwave devices and systems. Theory of transmission lines and waveguides. *Prep. Bachelor of Science degree in Electrical Engineering or Physics.*

3.881 Microwave Engineering Principles II
Continuation of 3.880. Circuit theory for waveguiding systems. Impedance matching and transformation. Passive microwave devices. Cavity resonators. *Prep. 3.880 or equivalent.*

3.882 Microwave Engineering Principles III
Advanced topics in microwave theory, the content to be determined in part by student interest. Topics to be covered may include propagation in anisotropic media; non-reciprocal and ferrite devices; beam-wave interactions; coupled mode theory; travelling wave devices; periodically loaded lines; couplers; polarizers; phase shifters; attenuators; microwave filter synthesis; microwave systems considerations. *Prep. 3.880 and 3.881 or equivalent.*

3.883 Advanced Electromagnetic Theory (4 q.h. credits)
Offered days. Includes the material given in 3.878 and 3.879 — Advanced Electromagnetic Theory I and II. *Prep. 3.876, Electromagnetic Theory II or 3.877, Electromagnetic Theory.*

3.886 Remote Sensing
The application of electromagnetic radiating for sensing the environment, subsurface geophysical exploration, and identifying remote objects. Basic goals are concerned with understanding the relevant electromagnetics in relation to the particular sensing system. Both time and frequency domain sensing systems will be covered. As time permits, the application of pattern recognition methods to electromagnetic sensing will be discussed. *Prep. 3.876, Electromagnetic Theory II or 3.877, Electromagnetic Theory.*

3.887 Three-dimensional Picture Processing
The application of computer, optical, and analytic methods in abstracting geometrical information from pictures. Pictorial presentation of data trains into multidimensional pictures. Methods will be studied for reconstructing three-dimensional objects from two-dimensional pictures. Applications will be in the areas of X-ray analysis, radar target identification, microscopy, and sensory perception. Students will have the chance to pursue individual projects during the term. *Prep. BS degree in Science or Engineering.*

3.890 Electromagnetic Wave Propagation I
Topics in wave propagation of prime importance in communications and space physics. Review of wave propagation in a homogeneous medium. Physical processes in the atmosphere. The formation and structure of the ionosphere. Basic magnetoionic theory. Propagation of waves in a spatially varying medium. Ray theory. *Prep. 10.9N2, Advanced Mathematics or equivalent.*

3.891 Electromagnetic Wave Propagation II
A two-course sequence covering topics in wave propagation that are of primary importance in communicators and space physics. It is to be expected that with the vast amount of material available in a very active and rapidly changing field, that there will be considerable variation in what is covered, depending on timeliness and class interest. Among topics that may be covered within the two-course sequence are: review of propagation in a homogeneous medium; physical processes in the atmosphere; formation and structure of the ionosphere; basic magnetoionic theory; propagation in spatially variable media; ray theory; applications of ionosphere propagation and reflection to radio communication. Effects of the geomagnetic field; irregularities ionospheric scatter; diversity techniques. *Prep. 3.877 or 3.876.*

3.893 Digital Computer Programming I
First quarter of a three-quarter sequence of systems programming and language processors. Topics include: machine structure, machine language, assembly language; assemblers, macros, macro-processors; searching and sorting; loaders; data structures, storage allocation; high-level languages; compilers; operating systems; management of memory, processors, devices; multiprocessing and multiprogramming. *Prep. B.S. degree in Engineering or Science and knowledge of a higher level programming language.*

3.894 Digital Computer Programming II
Continuation of 3.893. *Prep. 3.893, Digital Computer Programming I.*

3.895 Digital Computer Programming III
Continuation of 3.894. *Prep. 3.894, Digital Computer Programming II.*

3.898 Combinatorial Mathematics
An introductory course in applied combinatorial mathematics which treats selected topics in enumerative analysis. Particular subjects include permutations, combinations, generating functions, recurrence relations, and the principle of inclusion and exclusion. *Prep. 3.8A1, Mathematical Methods in Computer Science.*

3.899 Combinatorial Methods and Optimization Techniques
Continuation of 3.898 to cover Polya's theory of counting; selected topics in optimization techniques, which include transport networks, matching theory, linear programming, and an introduction to dynamic programming. *Prep. 3.898, Combinatorial Mathematics.*

3.8A1 Mathematical Methods in Computer Science
Algebraic concepts relevant to computer science; sets, relations, mapping, orderings, algebraic systems, Boolean algebras, groups, rings, finite fields, introduction to vector spaces and linear algebras over finite fields. *Prep. Bachelor of Science degree in Engineering or Science.*

3.8C1 Mathematical Methods in Electrical Engineering I
Complex variable theory; mapping by functions, definite and indefinite integrals, Cauchy integral formula, Laurent series, the residue theorem and branch points. Not open to Northeastern graduates who have completed 3.292. *Prep. Bachelor of Science degree in Engineering or Science.*

3.8C2 Mathematical Methods in Electrical Engineering II
A continuation of 3.8C1 that includes application of complex variable theory to Fourier theory, Hilbert transforms, and conformal transformations in the analysis of linear systems and in electrostatics; the Schwarz-Christoffel transformation, Poisson's integral formula and concept of analytic continuation. *Prep. 3.8C1, Mathematical Methods in Electrical Engineering I.*

3.8C4 Mathematical Methods in Electrical Engineering III
Linear algebraic equations; Gauss algorithm; linear operators in an n-dimensional vector space over infinite and finite fields; characteristic value problem minimal polynomial; functions of a matrix; equivalence, congruence, and similarity transformation canonical forms; polynomial matrices; Smith normal form; determinantal divisors; invariant polynomials elementary divisors; companion and Jordan canonical matrices; decomposition of a vector space into invariant subspaces with respect to a linear operator. *Prep. Bachelor of Science degree in Electrical Engineering.*

3.8C5 Mathematical Methods in Electrical Engineering IV
A continuation of 3.8C4. *Prep. 3.8C4, Mathematical Methods in Electrical Engineering III.*

3.8T0 Numerical Methods and Computer Applications (4 q.h. credits)
This course offered days covers the material in 3.8T1 and 3.8T2, Numerical Methods and Computer Applications I and II. *Prep. Bachelor of Science degree in Engineering, Mathematics or Physics, a working knowledge of FORTRAN.*

3.8T1 Numerical Methods and Computer Applications I
Survey of numerical methods applied to engineering and scientific problems with emphasis on machine implementation and problem solving; roundoff errors and cumulative errors; difference and summation calculus; roots of polynomials and nonlinear functions; orthogonal functions including polynomials, least squares, and Chebyshev approximation of functions; systems of algebraic equations, matrix notation, and machine implementation; inversion of matrices including iterative methods; sparse matrix techniques. *Prep. Bachelor of Science in Engineering. Mathematics, or Physics; a working knowledge of FORTRAN.*

3.8T2 Numerical Methods and Computer Applications II
Interpolation; numeric quadrature; numeric integration of ordinary differential equations including predictor-corrector methods; stiff dynamic equations, partial differential equations, approximations, boundary value problems. *Prep. 3.8T1, Numerical Methods and Computer Applications I.*

3.8T3 Numerical Methods and Computer Applications III
Linear and dynamic programming, steepest descent and simplex methods, with application to nonlinear functions in n-dimensional space; eigenvalues and eigenvectors of matrices; approximate location of eigenvalues; stability; Routh-Hurwitz criterion; more specialized techniques including the fast Fourier transform, digital simulation of analog computation, system modelling, etc. *Prep. 3.8T2, Numerical Methods and Computer Applications II.*

3.8T7 Digital Signal Processing I
A two-quarter sequence demonstrating the theory and practice of modern signal processing techniques. Characteristics of discrete signals and systems; sampling and A/D conversion; difference equations; convolution; the z-transform, the Fourier transform and the discrete Fourier transform; fast Fourier transform algorithms; chirp z-transform algorithm; digital filter realizations; design techniques for IIR and FIR digital filters; computer programs for filter design; quantization effects in digital signal processing.

3.8T8 Digital Signal Processing II
Continuation of 3.8T7. *Prep. 3.8T7 Digital Signal Processing I.*

3.8T9 Digital Signal Processing (4. q.h. credits)
This course, offered days, embodies the material in 3.8T7 and 3.8T8, Digital Signal Processing I and II. *Prep. 3.824, Linear Systems Analysis I or equivalent.*

3.8U1 Digital Signal Processing III
A continuation of the precepts acquired in Digital Signal Processing I and II or equivalent. Estimation of power spectra; the periodogram; modified periodogram; parametric methods for estimation of the power spectrum; autoregressive models; the Levinson algorithm; maximum entropy method and the Burg algorithm; moving average and autoregressive-moving average models; maximum likelihood methods; applications of methods in communications, speech processing and seismic signal processing. *Prep. Digital Signal Processing I and II or equivalent.*

3.8U4 Special Topics in Digital Signal Processing—Fast Algorithms for Digital Signal Processing
Fast algorithms for implementation of digital filters and discrete Fourier transforms: FFT, convolution algorithm, Number Theoretic Transforms (NTT), filtering computation, and polynominal transforms. *Prep. 3.8T7 and 3.8T8, Digital Signal Processing I and II.*

3.8U7 Two-Dimensional Digital Signal Processing
This course is concerned with two-dimensional digital signal processing which is finding wide applications in many diversified areas. Covers 2-D shift invariant systems along with their stability, the 2-D Discrete Fourier Transform (DFT) and its FFT implementation, and 2-D digital filter design and implementation. *Prep. 3.8T7 and 3.8T8, Digital Signal Processing I and II.*

3.9A1 Error Correcting Coding I
Error correcting codes and their decoding techniques which show promise for applications in digital communication, control and computer systems. Emphasis placed on the linear block codes based on algebraic structures; cyclic codes for random error correction (B-C-H codes) and burst error correction. Some knowledge of elementary aspects of modern algebra is desirable but not necessary. Not to be taken by students who have completed 3.904. *Prep. Bachelor of Science degree in Engineering or Science.*

3.9A2 Error Correcting Coding II
Convolutional codes and decoding including the Viterbi algorithm, arithmetic codes. Combination of codes. Coding for ranging and synchronization. Not to be taken by students who have completed 3.908. *Prep. 3.9A1, Error Correcting Coding I or 3.905, Information Theory and Coding.*

3.9A6 Optimal Control Theory
Introduction to optimal control theory. Variational caculus development of the maximum principle. Minimum time, minimum fuel, and minimum energy problems. The optimal linear regulator problem and the matrix ricatti equation. *Prep. 3.826, Linear Systems Analysis III.*

3.9A7 Design of Optimal Control Systems
A further study of optimal control with emphasis on control system design. The output regulator problem, the tracking problem, and system pole allocation. Numerical solutions using dynamic programming and steepest-descent algorithms. *Prep. 3.9A6.*

3.9A8 Control Systems II (4 q.h.)
Includes material given in 3.9A6, Optimal Control Theory, and 3.9A7, Design of Optimal Control Systems. *Prep. 3.826, Linear Systems Analysis III.*

3.9B1 Digital Processing of Speech Signals
Models of speech production, waveform coding of speech, transform coding of speech and speaker recognition systems. *Prep. 3.8T7 and 3.8T8, Digital Signal Processing I and II.*

3.9C1 Digital Communications I
Deals with the theoretical and practical aspects of digital communications in the presence of channel distortion and additive noise. Topics covered in this quarter include the basic

binary and M-ary modulation techniques; namely, PSK, PAM, FSK, orthogonal and bi-orthogonal signals, and their performance in an additive Gaussian noise channel; signal waveforms constructed from binary block and convolutional codes; hard-decision decoding and soft-decision decoding of coded signal waveforms; performance of coded waveforms in an additive white Gaussian noise channel. *Prep. 3.901, Applied Probability and Stochastic Processes II or 3.902, Applied Probability and Stochastic Processes.*

3.9C2 Digital Communications II
Signal design techniques for band-limited channels; Nyquist criteria; effect of channel amplitude and delay distortion on digital signals; discussion of several adaptive equalization algorithms for combatting intersymbol interference; maximum likelihood sequence estimation and the Viterbi algorithm; the characterization of fading multipath channels; diversity reception techniques; coding for fading channels. *Prep. 3.9C1, Digital Communications I.*

3.9D1 Digital Image Processing I
An introduction to the generation and processing of digital images. The course emphasizes the random-vector nature of digital images and uses linear system theory, matrices, and probability theory to develop the various topics. These include the generation of a digital image from the source, through the optical system, to the detector; sampling and quantization of the optical signal; and the enhancement techniques such as histogram mapping, contrast boosting, and edge sharpening. *Prep. 3.901 or 3.902.*

3.9D2 Digital Image Processing II
A continuation of 3.9D1. Topics include image restoration by Weiner filtering, maximum entropy estimation, singular value decomposition, and spatially varying filters, image coding with Huffman codes, DPCM, Transform (Walsh, KL, discrete cosine) coding, run-length encoding, adaptive optics, feature analysis, and hardware for a typical digital image processing system. *Prep. 3.9D1, Digital Image Processing I.*

The two-part sequence which follows serves to introduce students in engineering and physics to the notions of probability, random variables and stochastic processes. The subject matter is given below.

3.9E1 Compiler Construction I-A *
Lexical analysis, parsing, syntax-directed translation, and code generation for modern block-structured programming languages. Case studies of translation to, and interpretation of, intermediate languages. *Prep. 3.986 and 3.893 or equivalent.*

3.9E2 Compiler Construction I-B *
Continuation of 3.9E1.

3.9Z1 Engineer's Degree Reading
To be taken upon completion of 30 q.h. of satisfactory course work. NO CREDITS TOWARDS COURSE REQUIREMENTS GIVEN. Students allowed to register for a minimum of 4 q.h./quarter, maximum of 8 q.h./quarter.

---

* Both A & B courses must be successfully completed to receive credit.

3.9Z2 Electrical Engineer Degree Thesis
Prep. Admission to Engineer Degree Program.

3.9Z3 Engineer's Degree Thesis Continuation
Candidates to sign up for thesis continuation if their thesis is not completed after they have registered for 3 consecutive quarters or 10 q.h. of EE degree thesis. Continuation registration is required until the candidate graduates.

3.900 Applied Probability and Stochastic Processes I
Introductory probability, sample space and random variables, examples of discrete and continuous probability distribution functions, averages, moments and characteristic function, multivariate distributions, change of variables and functions of variables, central limit theorem, description of stochastic vectors. *Prep. Bachelor of Science degree in Engineering or Science.*

3.901 Applied Probability and Stochastic Processes II
General concepts of stochastic processes, stationarity and ergodicity, stochastic continuity and differentiation, the Gaussian process, linear systems with stochastic inputs, correlation functions and power spectra, matched filtering, stochastic orthogonality and linear mean-square estimation filtering and prediction. *Prep. 3.900, Applied Probability and Stochastic Processes I.*

3.902 Applied Probability and Stochastic Processes (4 q.h. credits)
Includes the material given in 3.900, Applied Probability and Stochastic Processes I and 3.901, Applied Probability and Stochastic Processes II. *Prep. Bachelor of Science degree in Engineering or Science.*

3.903 Information Theory
Deals principally with three aspects of information theory: the statistical description of sources and the probabilistic measure of their information contents, the determination of channel capacity, and the fundamental coding theorems. *Prep. 3.900, Applied Probability and Stochastic Processes I or 3.902, Applied Probability and Stochastic Processes or Probability.*

3.905 Information Theory and Coding (4 q.h. credits)
Includes the material given in 3.903, Information Theory and 3.9A1, Error Correcting Coding I. *Prep. 3.900, Applied Probability and Stochastic Processes I or 3.902, Applied Probability and Stochastic Processes.*

3.906 Detection and Estimation Theory A *
This course presents the classical theory of detection and estimation of signals in noise with emphasis on computer implementation of the theory. Particular topics include: hypothesis testing criteria; coherent detection of M-ary signals; diversity receiver; calculation of error probabilities. *Prep. 3.901, Applied Probability and Stochastic Processes II or 3.902, Applied Probability and Stochastic Processes.*

---

* Both A & B courses must be successfully completed to receive credit.

3.907 Detection and Estimation Theory B *
This is a continuation of 3.906. Topics include: detection in colored noise; parameter estimation using Bayes, maximum-likelihood, and maximum land posteriori criteria; applications in pattern recognition and radar. *Prep. 3.906, Detection and Estimation Theory A.*

3.908 Special Topics in Communication Theory
Current aspects of communication theory not covered in previous courses. Subject matter may change from year to year.

3.909 Detection and Estimation Theory (4 q.h. credits)
Offered days. Includes the material given in 3.906 and 3.907, Detection and Estimation Theory A and B. *Prep. 3.901, Applied Probability and Stochastic Processes II or 3.902, Applied Probability and Stochastic Processes.*

3.910 Nonlinear Systems I
Operators and functionals. Functional power series representation of nonlinear systems. Functional representation of the response of a nonlinear system when its input is either a constant, a sinusoid, a transient. System transforms. Applications to the analysis and synthesis of nonlinear systems in terms of functional power series. *Prep. An undergraduate course in Signals and Systems and 3.900, Applied Probability and Stochastic Processes I or equivalent.*

3.911 Nonlinear Systems II
Nonlinear systems with random inputs. Functional representation of the response of a nonlinear system when its input is a random process. Orthogonal systems of functionals. Representation and analysis of nonlinear systems in terms of orthogonal systems of functionals. The optimum nonlinear filter, predictor, and general operator. Special classes of nonlinear systems. Determination of optimum nonlinear systems for generalized error criteria. *Prep. 3.910, Nonlinear Systems I and either 3.901, Applied Probability and Stochastic Processes II or 3.902, Applied Probability and Stochastic Processes.*

3.912 Nonlinear Systems III
Functional analysis of systems characterized by nonlinear differential equations. Operator approach to system theory and its relationship to differential equation representations. The methods of iteration in nonlinear theory and its application to feedback systems. *Prep. 3.911, Nonlinear Systems II.*

3.913 Optical Storage and Display
Survey of materials and methods for the storage and display of information. Topics included are: photographic film, holograms, storage tubes, magneto-optical films, photochromic materials, electro-optical crystals, evaporated thin films and liquid crystals. *Prep. Bachelor of Science degree in Engineering or Physics or equivalent.*

3.914 Electro-Optics I
Survey of the basic concepts necessary for understanding and evaluating the optics involved in electro-optical systems. The optical system as a linear system; matrix methods; diffraction and interference; imaging and aberrations. *Prep. Bachelor of Science degree in Engineering or Physics.*

3.915 Electro-Optics II
Survey of the basic concepts necessary for understanding electro-optical devices. Wave propagation in isotropic and nonisotropic media; optics of crystals; polarization; optical resonators; guided waves; modulators and detectors; thin film optics. *Prep. Bachelor of Science degree in Engineering or Physics.*

3.916 Fourier Optics I
This two-quarter sequence covers: optical diffraction and imaging problems as linear systems; necessary tools of Fourier Analysis and linear systems analysis which occur when solving the scalar wave equation; waves and their properties; reflection, refraction, polarization, and propagation of waves; foundations of scalar diffraction theory — including Fresnel and Fraunhofer diffraction, interferometry, division of amplitude, division of wavefront, interferometric instrumentation, Fourier transforming, image properties of lenses, coherent and incoherent imaging; and advanced topics in the application of communication theory to optical problems, transfer and spread functions, spatial filtering, and holography. *Prep. 3.915, Electro-Optics II or equivalent.*

3.917 Fourier Optics II
Continuation of 3.916. *Prep. 3.916, Fourier Optics I.*

3.921 Optical Properties of Matter I — Crystals
Optics of crystals; classification and effects of crystal symmetry on optical properties; classical description of wave propagation in crystals; applications of the theory to modulation, pulse generation, nonlinear optics. *Prep. Bachelor of Science in Engineering or Physics or equivalent.*

3.922 Optical Properties of Matter II
Introduction to electro-optical and magneto-optical effects in material media; linear and nonlinear optical materials; elasto-optic and acousto-optical materials; polarization and propagation effects; modulation. *Prep. 3.921, Optical Properties of Matter I — Crystals.*

3.923 Optical Properties of Matter III
Thin films and optical fibers; multilayer filters; dichroics; integrated optics. *Prep. 3.922, Optical Properties of Matter II.*

Additional courses on the optics sequence are 3.980, 3.981, 3.982, 3.983, and 3.984.

3.925 Power Circuit Analysis I
Fundamental concepts of single-phase and polyphase power systems; definitions of terms; use of per unit quantities; equivalent circuits of symmetrical 3-phase systems; introduction to symmetrical components; short circuits on systems with a single power source. *Prep. Bachelor of Science degree in Electrical Engineering.*

3.926 Power Circuit Analysis II
This course is a continuation of 3.925, Power Circuit Analysis I. Sequence impedances of various power-system elements are considered from application point of view; unsymmetrical faults on otherwise symmetrical 3-phase systems; open conductors and asymmetrical connections and loadings; analysis of simultaneous faults on 3-phase systems. *Prep. 3.925, Power Circuit Analysis I.*

3.927 Power Circuit Analysis III
This course is a continuation of 3.926, Power Circuit Analysis II. Introduction of Clarke components and applications in analysis of asymmetrical systems and faults; application of Clarke components to the solution of surge phenomena problems; transmission line theory; fundamentals of systems stability. *Prep. 3.926, Power Circuit Analysis II.*

3.928 Analysis of Power Systems (4 q.h. credits)
Offered days. This course is designed to provide the basic material, including special mathematical techniques, applicable to the solution of problems associated with power systems. The sequence-impedance characteristics of various power-system elements are investigated with emphasis on application rather than design. Abnormal situations including simultaneous faults and system transients are treated in depth, making use of Clarke components and modified Clarke components as well as symmetrical components. Polyphase transmission line theory, system protection and system stability are introduced and discussed briefly. *Prep. Bachelor of Science degree in Electrical Engineering.*

3.929 Solid State AC and DC Motor Control Systems
The application of solid-state devices to the control of AC and DC electrical machinery, including rectifiers, inverters, choppers and cyclo-converters, as applied to drive systems in industry and transportation. The course will emphasize a case method approach. *Prep. A background in electric machinery.*

3.930 Power System Planning
Engineering and economic considerations underlying the planning and development of modern interconnected power systems. Consideration of overall planning strategies involved in economic comparison of alternative development schemes. *Prep. 3.925, Power Circuit Analysis I.*

3.931 Power System Planning (4 q.h. credits)
Offered days. Includes the material given in 3.930 but with more extensive and in-depth coverage. *Prep. 3.928, Analysis of Power Systems or equivalent.*

3.932 Power Systems Protection
Consideration of protection applied to generation, transmission, and distribution. Investigation of the characteristics and operating principles of various methods of protective relaying; analysis of current techniques pertaining to system protection. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

3.933 Power System Transients
Transients in power systems due to system switching, lightning, or faults. Traveling-wave phenomena; insulation coordination; overvoltages due to disturbances on the system; surge protection. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

3.935 Computers in Power Systems I
Techniques used in solving power system problems with the digital computer. Matrix formulations are examined, followed by a detailed treatment of the short-circuit problem, including balanced and unbalanced faults. Various iterative techniques are studied for the solution of the power-flow problem. *Prep. Bachelor of Science degree in Electrical Engineering or equivalent.*

3.936 Computers in Power Systems II
Practical considerations of solving large scale networks are discussed. Network reductions, distribution factors and contingency analysis techniques are developed. Digital models for regulated generators, fixed and load tap changing transformers and HVDC transmission lines are examined. Computer methods for economic dispatch, loss coefficients and application of pumped hydro are developed. *Prep. 3.935, Computers in Power Systems I.*

3.940 Electric Machinery Theory I
Review of magnetic circuit concepts and electromechanical energy-conversion principles; steady-state analysis of transformers, synchronous machines, and induction machines. *Prep. Bachelor of Science degree in Electrical Engineering or 3.975, 3.976, and 3.977, Precis of Modern Electrical Engineering I, II, and III.*

3.941 Electric Machinery Theory II
Mathematical description of a synchronous machine; per-unit representation; steady-state theory and transient performance; flux distribution and saturation in synchronous machines. *Prep. 3.940, Electric Machinery Theory I.*

3.942 Electric Machinery Theory III
Review of transient behavior of synchronous machines; stability studies and excitation systems; synchronous machine modeling; generator protection; trends in development of large generators. *Prep. 3.941, Electric Machinery Theory II.*

3.943 Advanced Power Laboratory
Offered days. In-depth investigations of the steady-state and dynamic modes of operation of rotating machines. Polyphase rectification and control circuits. Experimentation in other related power areas. *Prep. Bachelor of Science degree in Electrical Engineering.*

3.944 Special Topics in Power
Offered days. (Part-time students may enroll in this course only by special arrangement.) Directed reading and discussion of topics of special interest in the power field. Series of lectures by guest speakers from industry on topics of particular interest to the power student. *Prep. Permission of instructor.*

3.945 Power System Dynamics
Transient system models; small and large scale oscillations; solution of swing equation for single and multi-generator cases; load frequency and voltage controllers and transient stability. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

3.950 Systems Analysis I-A *
Review of probability and statistics. Elements of Markov processes, queuing as a Markov process. Finite and infinite queue systems, multiple-server, parallel and sequential queuing; fundamentals of reliability theory. *Prep. Bachelor of Science degree in Engineering or Science.*

---

* Both A & B courses must be successfully completed to receive credit.

3.951 Systems Analysis I-B *
Flow-graph representation of queuing systems, equivalence of flow-graph and analog-computer representation; fundamental concepts in game theory; solution of rectangular games; pure and mixed strategies, maximin and minimax principle; zero and non-zero-sum games, infinite games; transformation of games into linear programming problems. Other methods of solving competitive-situation problems. *Prep. 3.950, Systems Analysis I-A.*

3.952 Systems Analysis II
Modelling of systems problems in terms of linear programming approach. Transportation problem; graphical representation and solution of linear-programming problems; allocation problem; simplex method; concept of duality and its use in linear programming. *Prep. 10.8A4, Advanced Mathematics or 10.9N2, Advanced Mathematics.*

3.953 Systems Analysis III
Optimization of stochastic systems. Markov-process approach to the analysis of probabilistic systems. Z-transform analysis of Markov processes. Solution of sequential decision processes by value and policy iteration. Single-chain and multi-chain systems. Sequential decision processes with discounting. Machinery and car replacement problem, and other applications. *Prep. 3.950, Systems Analysis I-A, 3.952, Systems Analysis II, 10.8G1, Probability or equivalent.*

3.954 Systems Analysis (4 q.h. credits)
Offered days. Includes the material given in 3.950 and 3.951 — Systems Analysis I-A and I-B. *Prep. Bachelor of Science degree in Engineering or Science.*

3.955 Studies in Electric Power Transmission I
Elements in the design of AC overhead transmission lines; thermal limitations, series and shunt compensation, environmental effects; consideration of transposition, induced effects, and insulation level. Underground alternatives to overhead lines. Elements of distribution. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

3.956 Studies in Electric Power Transmission II
Fundamental concepts of high voltage DC power transmission; rectifier and invertee performance; regulation; protection; reactive power and filter requirements; practical arrangement of DC lines; the impact of a DC line on overall power system operation. *Prep. 3.927, Power Circuit Analysis III or equivalent.*

3.957 Control System Analysis
Classical analysis techniques for continuous and sampled-data control systems. Discussion of stability criteria; application of root-locus and Bode methods for complementary time and frequency-domain analysis. Computer simulation of typical control systems will be emphasized. *Prep. Bachelor of Science degree in Engineering; knowledge of transform analysis and some familiarity with FORTRAN.*

3.958 Control System Synthesis
A review of cascade and feedback compensation techniques with the use of classical criteria for design of continuous and sampled-data control systems. Consideration of the multiple-input problem. A survey of pole-zero synthesis methods; and comparison with

other techniques. Computer simulation of design examples. *Prep. 3.957, Control System Analysis or equivalent.*

3.959 Control Systems I (4 q.h. credits)
Includes the material given in 3.957, Control System Analysis and 3.958, Control System Synthesis. Open to qualified undergraduate students. *Prep. Knowledge of transform analysis and some familiarity with FORTRAN.*

3.963 Stochastic Control Theory
Statistical models for random signals; representation of dynamic systems excited by stochastic inputs. Optimal filtering, prediction and smoothing for discrete and continuous systems. Observer theory and feedback of estimated states for effective closed-loop control in a noisy environment. *Prep. 3.900, Applied Probability and Stochastic Processes I and 3.826, Linear Systems Analysis III.*

3.964 Estimation, Identification, and Control
Estimation theory for dynamic systems based on Bayesian and maximum likelihood methods. The system identification problem. Implementation of numerical algorithms for parameter identification and adaptive control. *Prep. 3.963, Stochastic Control Theory.*

3.965 Control Systems III
Includes the material given in 3.963, Stochastic Control Theory and 3.964, Estimation, Identification, and Control. *Prep. 3.900, Applied Probability and Stochastic Processes I and 3.826, Linear Systems Analysis III.*

3.966 Switching Theory I (4 q.h.)
This course offered days covers the material in 3.967 and 3.968, Switching Theory I-A and I-B. *Prep. 3.8A1 Mathematical Methods in Computer Science.*

3.967 Switching Theory I-A *
Logical design of combinational switching circuits, including minimization and decomposition of switching functions; multiple output networks; symmetric networks; threshold logic, fault detection. Logic design of sequential switching circuits including finite-state machine model; iterative networks; capabilities and limitations of finite-state machines; state equivalence; synthesis of asynchronous sequential circuits; state assignment problem and partition theory; machine decomposition. *Prep. Bachelor of Science degree in Engineering or related science.*

3.968 Switching Theory I-B *
Logical design of sequential switching circuits, including the finite-state machine model; iterative networks; capabilities and limitations of finite-state machines; state equivalence; synthesis of asynchronous sequential circuits; state assignment problem and partition theory; machine decomposition. *Prep. 3.967, Switching Theory I-A.*

3.969 Switching Theory II
Selected topics from the theory of finite automata, including such topics as machine experiments; information lossless machines; linear sequential machines; finite-state recognizers. *Prep. 3.968, Switching Theory I-B or 3.966, Switching Theory I.*

---

* Both A & B courses must be successfully completed to receive credit.

3.972 Digital Computer Design I-A *

3.973 Digital Computer Design I-B *
These courses are directed towards the design of a complete computer in register transfer language. Analysis and synthesis of combinational and sequential circuits. Organization and detailed logic design of an elementary digital computer. Other topics may include bus organization, interfacing with asynchronous peripherals, digital logic families, hardware/software tradeoffs, address modes, and memory hierarchies. *Prep. Bachelor of Science degree in Engineering or related science.*

3.974 Digital Computer Design II
Topics in microprogramming and emulation including microprogramming concepts and techniques; microprogramming design approach using register transfer notation and precedence graphs; microprogrammed computers, bit-slice microprogramming, microprogramming a specific machine for emulation using a microprogramming language and its simulator; current trends in microprogramming languages and support tools. *Prep. 3.973, Digital Computer Design I-B.*

***3.975 Precis of Modern Electrical Engineering I**
Prep. Bachelor of Science degree in Engineering or Science plus knowledge of matrix algebra.

***3.976 Precis of Modern Electrical Engineering II**
Prep. Bachelor of Science degree in Engineering or Science.

***3.977 Precis of Modern Electrical Engineering III**
Prep. Bachelor of Science degree in Engineering or Science.

***3.978 Precis of Modern Electrical Engineering IV**
Prep. Bachelor of Science degree in Electrical Engineering or Science.

The preceding four precis courses are intended primarily for those whose undergraduate major was in an engineering or scientific field other than electrical engineering. They are also recommended for students 5 to 10 years away from their bachelor's degree in electrical engineering who feel the need for a review of electrical science. They are open only to students in these categories. The material is basically undergraduate in nature but the viewpoint and depth are at the mature level appropriate to graduate students. Part I deals with the theory of electric circuits and linear systems, Part II with electronics, Part III with field theory from the engineering viewpoint, and Part IV with communication theory especially spectral analysis correlation and modulation.

3.979 Digital Computer Design (4 q.h. credits)
This course, offered days, embodies the material in 3.972 and 3.973, Digital Computer Design I-A and I-B. *Prep. Bachelor of Science degree in Engineering or related Science.*

3.980 Optical Instrumentation Design Concepts
An introduction to the design of optical instrumentation. Principles and basic concepts rather than a rundown of known optical systems. In sequence the topics are: introduction,

---

* Prerequisite courses.

mechanical shock and vibration, kinematic designs, application of third order aberrations, simple optical ray tracing, optical testing, tolerances, optical instrumentation, philosophy, functional design, design for quantity production, quality assurance, "special order" design, industrial design, examples and exercises. *Prep. Bachelor of Science degree in Engineering or Physics or equivalent.*

3.981 Principles of Optical Detection I — Application
Laws governing radiation and radiometry; properties of real radiation sources; detailed description of detection devices (image forming and signal generating); noise; contrast and MTF; detection systems (imaging devices and ranging devices); electro-optical detector systems analysis. *Prep. Bachelor of Science degree in Engineering or Physics or equivalent.*

3.982 Principles of Optical Detection II — Theory
Review of detector parameters; statistics of detector noise; practical considerations in real detectors; detection, resolution and recognition of signals; heterodyne detection and parametric amplification; sub-nanosecond pulse detection calibration of electro-optical detectors; detectors as system components. *Prep. Bachelor of Science degree in Engineering or Physics or equivalent.*

3.983 Fourier Optics III
The third in a series covering current topics of interest in this field and optical instrumentation. Application of coherence phenomena to optical instrumentation such as microdensitometers, microscopes, viewers, cameras, spectraphotometric and interferometric instruments; applications of holography, optical data processing and computing, holographic memories, optical modulation, noise and its effects on data collection, synthetic aperture optics and medical application of laser optics. *Prep. 3.917, Fourier Optics II.*

3.984 Spectroscopic Instrumentation
Survey of optical instrumentation employed in analysis and control situations; modern methods of spectrometry and interferometry; optimization of analytical systems; topics in electron spectroscopy, X-ray spectroscopy, microwave spectroscopy, and related fields. *Prep. Bachelor of Science degree in Engineering or Science.*

3.985 Fundamentals of Language and Machine Theory I
First of a three-quarter sequence in theoretical models of languages and computation. Topics include: formal grammars, parsing, lexical analysis techniques; syntax-directed translation schemes; regular and context-free languages; finite automata, pushdown automata; more general languages and their corresponding machine recognizers; an introduction to computability theory; solvability and unsolvability; computational complexity considerations. *Prep. 3.8A1, Mathematical Methods in Computer Science.*

3.986 Fundamentals of Language and Machine Theory II
Continuation of 3.985 *Prep. 3.985, Fundamentals of Language and Machine Theory I.*

3.987 Fundamentals of Language and Machine Theory III
Continuation of 3.986 *Prep. 3.986, Fundamentals of Language and Machine Theory II.*

3.988 Special Topics in Computer Science
Aspects of Computer Science not covered in other courses. The subject matter may change from year to year.

3.989 Computer Peripherals
Survey of various types of modern computer peripherals, systems considerations, displays (CRT; control units, editing features, graphics, etc.); mass storage (magnetic surfaces; flying heads, recording techniques, disks; file organization, search strategies, mass storage, software, etc.); communications terminals (modems, control procedures, store and forward, multiplexers, etc.); tape units (types, consideration of cost vs. performance, tape labels and formats, magnetic recording on tapes, design features, etc.); future trends in peripherals. *Prep. Bachelor of Science degree in Electrical Engineering or related engineering or sciences.*

3.990 Seminar I
A library survey of a selected topic in the general field of electrical engineering with an oral presentation based on this survey. Participation in the departmental seminar program of guest lectures. *Prep. Bachelor of Science degree in Engineering or Science.*

3.991 Seminar II
The preparation of a research paper suitable for publication in a professional journal, plus an oral presentation of this report. *Prep. 3.990, Seminar I.*

3.993 Doctoral Seminar I (non-credit)
This requirement will be satisfied by the student presenting a seminar to the Electrical Engineering Department on a subject related to his/her Ph.D. thesis. The thesis supervisor will coordinate the seminar. *Prep. Passing of Ph.D. Qualifying Exam.*

3.995 Master's Thesis
Analytical and/or experimental work conducted under the auspices of the department. *Prep. Bachelor of Science degree in Engineering or Science.*

3.996 Doctoral Thesis
Theoretical and/or experimental work conducted under the auspices of the department. *Prep. Passing of Ph.D. Qualifying Exam.*

3.997 Doctoral Reading
Material approved by the candidate's adviser. (Only S or F grades will be assigned for this course.) *Prep. Passing of Ph.D. Qualifying Exam.*

3.998 Special Problems in Electrical Engineering
Theoretical or experimental work under individual faculty supervision. *Prep. Consent of dept. chairman.*

CHEMICAL ENGINEERING

Prerequisite courses and advanced undergraduate courses will not be given credit unless approved by an academic adviser. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. All chemical engineering courses and courses from other departments that are of an advanced undergraduate or

prerequisite level are indicated by an asterisk (*) and apply to the academic adviser approval regulation.

4.801 Advanced Chemical Engineering Calculations (4 q.h. credits)
Fundamental process principles leading to an understanding of the stoichiometric principles of chemical process plants. The study of complex material and energy balances is undertaken with the view to apply these principles to actual large chemical plant conditions. *Prep. Bachelor of Science degree in Chemical Engineering, including differential equations.*

4.802 Chemical Engineering Mathematics (4 q.h. credits)
Formulation and solution of problems involving advanced calculus as they arise in chemical engineering situations. Methods covered will include ordinary differential equations, series solutions, complex variables, Laplace transforms, partial differential equations, and matrix operations. Emphasis will be placed on methods for formulating the problems. It will be assumed that the student has been exposed to some of these topics in appropriate mathematics courses. *Prep. Bachelor of Science degree in Chemical Engineering, including Mathematical Analysis.*

4.803 Numerical Techniques in Chemical Engineering (4 q.h. credits)
Digital computer applications to chemical engineering problems. Topics covered include location of roots of linear and nonlinear equations, numerical integration, and curve-fitting techniques with emphasis on the numerical solution of ordinary and partial differential equations and to the subject of linear algebra. *Prep. Bachelor of Science degree in Chemical Engineering.*

4.806 Optimization Techniques (4 q.h. credits)
Several mathematical optimization techniques are developed and applied to chemical engineering problems. Emphasis on a thorough understanding of a single, representative technique selected from among many within its class. Topics include single variable search (Fibonocicci Search), multidimensional search (Pattern Search), linear systems (Linear Programming) and sequential operations (Dynamic Programming). *Prep. Bachelor of Science degree in Chemical Engineering.*

4.811 Chemical Engineering Thermodynamics (4 q.h. credits)
Classical thermodynamics as a method of approach to the analysis of processes of interest to chemical engineers. A study of chemical and phase equilibria involving the various states of matter; prediction and correlation of physical, chemical, and transport properties of gases and liquids; elementary concepts of quantum and statistical mechanics to interpret the empirical properties of classical thermodynamics. Fundamental principles are reviewed to the extent needed. *Prep. Bachelor of Science in Chemical Engineering.*

4.812 Chemical Equilibria
This course embodies those elements of 4.811 which are concerned with the thermodynamics of chemical equilibria. Topics covered include auxiliary functions, the conditions of equilibrium, equilibrium of reactions involving gases, and the phase rule as applied to heterogeneous reaction systems. *Prep. Graduate Standing in Chemical Engineering.*

4.821 Corrosion Fundamentals
Economic factors, basic theories, types, behaviors of specific systems, and protection against corrosion are studied. Wherever possible, engineering applications of the principles are emphasized. *Prep. Bachelor of Science degree.*

4.823 Transport Phenomena
Momentum rate conservation equations for steady-state fluid flow in two-dimensional boundary layers are presented and solved to obtain the fluid velocity profiles. These results are utilized in the consideration of heat and mass transfer phenomena at a fluid-solid interface. The development of surface renewal theory is presented and applied to the description of heat and mass transfer phenomena. *Prep. Bachelor of Science in Chemical Engineering.*

4.824 Transport Processes
A consideration of the relationships of mass, momentum, and energy transport. Fundamental equations of change for these types of transport are derived and solved for various chemical and physical systems. *Prep. Advanced Mathematics or undergraduate Transport Phenomena or permission.*

4.827 Chemical Process Control I
Review of classical control techniques; state variable representation and analysis of continuous systems with process dynamics and control applications in chemical engineering. *Prep. Graduate Standing in Chemical Engineering.*

4.828 Chemical Process Control II
Continuation of 4.827 to include multivariable control problems in chemical engineering with associated problems from the chemical engineering literature. *Prep. 4.827.*

4.829 Chemical Process Control (4 q.h. credits)
Review of time, Laplace, and frequency domain process dynamics and control. State variable representation and analysis of continuous systems with applications in chemical engineering. Multivariable control problems. Digital simulation of control systems. *Prep. Graduate standing in Chemical Engineering or permission.*

4.830 Computer Process Control (4 q.h. credits)
Computer control hardware and software. Z-transform, pulse transfer functions, and data holds. Open and closed-loop response and design of sampled-data systems. Computer control algorithms. Digital simulation of sampled-data systems. *Prep. Graduate standing in Chemical Engineering or permission.*

4.832 Chemical Data Estimation
Methods of obtaining physical and thermodynamic properties of chemical compounds and systems without resorting to laboratory investigation. Latest empirical relationships and physical and thermodynamic laws are introduced to obtain data for plant design and other chemical and engineering uses. *Prep. Bachelor of Science degree.*

4.833 Research Techniques I (4 q.h. credits)
The essential techniques of research including experimentation, mathematical modeling, data reduction, and graphical presentation techniques. For students in the non-research

options (M.S. and D.Eng.). *Prep. Bachelor of Science degree and registration in non-thesis M.S. or D.Eng. program in Chemical Engineering.*

4.834 Research Techniques II (4 q.h. credits)
Continuation of 4.833. *Prep. 4.833.*

4.835 Analytical and Numerical Techniques (4 q.h. credits)
For students interested in solving comprehensive problems using computer methods. Problems solved in the course will be based on the interest of the students and staff and will be individual. *Prep. Bachelor of Science degree and knowledge of digital computer programming.*

4.837 Modeling and Simulation of Chemical Process (4 q.h. credits)
This course includes the material given in 4.838. In addition, use of chemical process simulation programs, optimal heat exchanger networks, and additional articles from the literature are treated. *Prep. Graduate standing in Chemical Engineering.*

4.838 Modeling and Simulation of Chemical Processes
Algorithms for structuring steady-state design calculations. Tearing recycle streams for iteration on minimum streams and minimum parameters. Convergence acceleration for calculations involving recycle streams. Algorithms for design variable selection. *Prep. Graduate standing in Chemical Engineering or permission.*

4.840 Advanced Management Techniques in the Chemical Industry (4 q.h. credits)
Management techniques applied to the chemical industry. Special attention to management of research organizations and to management of engineering services, such as design, computer, and related activities. *Prep. Graduate standing.*

4.845 Advanced Plant Design Concepts (4 q.h. credits)
Modern approaches to plant design; computer-oriented design, analysis and simulation of chemical processes, use of strategy decision making in design, advanced scheduling and planning techniques. *Prep. Bachelor of Science in Chemical Engineering.*

4.850 Chemical Process Pollution Control (Water) (4 q.h. credits)
Provides chemical engineering students with basic fundamentals for handling environmental problems in the chemical process industries. Water quality requirements and industrial waste characteristics; wastewater treatment processes applicable to environmental engineering; biological treatment processes and equipment; comprehensive design problems involving biological and tertiary treatment; the economics of water treatment and reuse. *Prep. Graduate standing in Chemical Engineering.*

4.855 Wastewater Treatment Technology
Industrial waste treatment technology for various specific contaminants found in industrial wastes with emphasis on the chemical process industries. Information on sources and levels of contaminants, existing methods of treatment, levels of treatment attainable, and associated costs. *Prep. Graduate standing in Chemical Engineering.*

4.861 Fuel to Fuel Conversion
Energy problems associated with the oil, gas, and coal industries. The relative merits of various processes for converting one fuel to another, including the gasification of coal

to produce either a low-BTU gas or pipeline quality gas. Production of oil from oil shale, coal, and tar sands. *Prep. Bachelor of Science degree.*

4.862 Solar Energy Thermal Processes
Covers fundamental thermal processes involved in obtaining useful heat from flat-plate solar collectors. The components required in an active solar energy collection system are analyzed and the economics of the system are considered. *Prep. Bachelor of Science degree.*

4.870 Polymer Science (4 q.h. credits)
Basic concepts of polymers, thermodynamics of polymer solutions and measurement of molecular weight. Physical and chemical testing of polymers. Crystallinity in polymers and rheology of polymers. Physical and chemical properties of polymers. Mechanisms and conditions for polymerization of polymers including step-reaction, addition and co-polymerization. Discussion of carbon-chain polymers, fibers and fiber technology. *Prep. Bachelor of Science degree in Chemical Engineering or Chemistry.*

4.871 Fundamentals of Polymer Processing (4 q.h. credits)
Transport properties of polymer solutions and polymer melts. Modeling and design of polymer processing equipment. Flow models for processes involving heat, mass, and/or momentum transfer. Analysis of flow stability and elastic phenomena. Applications to the design of equipment for extrusion, calendering, coating, fiber spinning, tubular film blowing, injection molding and mixing. *Prep. B.S. in Engineering.*

4.872 Principles of Polymerization (4 q.h. credits)
Introduction to polymers and polymer properties. Mechanisms of polymerization including step polymerization, radical-chain polymerization, emulsion polymerization, ionic-chain polymerization, chain copolymerization and ring-opening polymerization. Stereo chemistry of polymerization and synthetic reactions of polymers. Applications to reactor design of industrially important polymers. *Prep. B.S. in Chemistry or Chemical Engineering.*

4.890 Heterogeneous Catalysis (4 q.h. credits)
Experimental methods required for determining the surface area and pore structure of catalyst carriers are discussed. These structural characteristics are utilized to estimate mass and heat transport rates within porous catalysts in order to determine their effectiveness with respect to chemical reaction. Mechanisms for chemical poisoning of catalysts are also analyzed. Reactions of practical interest are used to illustrate the applications of heterogeneous catalysis to modern chemical processing problems. *Prep. Bachelor of Science degree in Chemical Engineering.*

4.891 Kinetics of Chemical Processes
The theoretical foundations required for the analysis of elementary chemical reaction rates, such as collision theory, particle dynamics, and transition state theory are presented. Consideration is given to the theory of monomolecular reactions and the effect of solvent and electrostatic forces on liquid phase reaction rates. Homogeneous catalysis and selected free-energy correlations are covered. *Prep. Bachelor of Science degree in Chemical Engineering.*

4.899 Special Topics in Chemical Engineering (4 q.h. credits)
Topics of interest to the staff member conducting this class are presented for advanced study. A student may not take more than one Special Topics course with any one instructor. *Prep. Permission of department staff.*

4.973 Chemical Process Heat Transfer (4 q.h. credits)
Empirical methods and calculations used to design heat transfer equipment for the chemical process industries. Review of basic heat transfer principles. Shell-and-tube calculations for liquid and/or vapor phase heat transfer. Direct contact and other special heat exchanger applications. *Prep. Bachelor of Science in Chemical Engineering.*

4.974 Selected Topics in Fluid Mechanics (4 q.h. credits)
Discussion of statics, kinematics, and stress concepts associated with fluids. Formulation of the general equations of motion with application to laminar and turbulent flow. Topics on boundary layer theory and compressible flow are included. *Prep. Bachelor of Science in Chemical Engineering.*

4.978 Separation Processes (4 q.h. credits)
Calculation and design methods used in processes involving mass transfer. Topics covered include vapor liquid equilibria for binary and multicomponent systems, multicomponent distillation, absorption and extraction. Emphasis is placed on methods and techniques which are common to many separation processes. *Prep. B.S. degree in Chemical Engineering.*

4.990 Seminar
Topics of an advanced nature are presented by staff, outside speakers, and students in the graduate program. This course must be attended by all master's degree candidates. *Prep. Admission to graduate program in Chemical Engineering.*

4.991 Thesis (Master's Degree)
Analytical and/or experimental work conducted under the supervision of the department. For master's degree requirement. *Prep. Admission to Master of Science program in Chemical Engineering.*

4.995 Thesis (Ph.D. Degree)
Theoretical and experimental work conducted under the supervision of the department. *Prep. Admission to doctoral program in Chemical Engineering.*

4.996 Thesis (D. Eng. Degree)
Theoretical and experimental work conducted under the supervision of the department. *Prep. Admission to doctoral program in Chemical Engineering.*

INDUSTRIAL ENGINEERING, ENGINEERING MANAGEMENT, AND INFORMATION SYSTEMS

Prerequisite courses and advanced undergraduate courses will not be given credit unless approved by an academic adviser. Approval must be made on a graduate engineering petition form and submitted to the Graduate Engineering office. A maximum of six quarter hours of credit at this level may be applied toward a Master's degree. The industrial engineering courses listed below and courses from other departments that are of an advanced undergraduate or prerequisite level are indicated by an asterisk (*) and apply to the six quarter hour maximum regulation.

5.801 Analysis of the Industrial Enterprise I
Introduction to business organization, management and operation. Business responsibility to employees, its product, the customer and to the environment in which it operates. What faces the industrial enterprise in its effort to become profitable.

5.802 Analysis of the Industrial Enterprise II
A survey of modern planning, forecasting and budgeting. The financial markets; investing, speculating. Economic growth and controls. The interaction of politics, government and government controls on the industrial enterprise. Concerns of the engineering manager with these topics. *Prep. 5.801, Analysis of the Industrial Enterprise I.*

5.803 Industrial Organizations
An analysis of the purpose and functioning of organizations as the basic networks for achievement of goals through coordination of effort, communication, and responsibility. The approach will emphasize the role and function of engineering in organizations and will be based on modern behavioral science concepts. *Prep. Admission to program.*

5.805 Industrial Budgeting for Engineers
Budgeting plans, programs, and reports for industry today; an introduction to the essentials of fixed and variable budgeting for production, inventory, sales, cash, capital, and cost-volume-profit analysis. *Prep. 5.810, Industrial Accounting for Engineers or equivalent.* Offered alternate years with 5.811.

5.806 Production Forecasting
Econometric methods of forecasting the demand for industrial products; emphasis on techniques applicable to individual companies and the total demand. The principal tool used is the mathematical model of the causal factors with special attention to determining the reliability of the model. *Prep. 5.963, Statistics or equivalent.*

***5.808 Basic Engineering Economy**
Economic analysis in formulating business policies and selecting alternatives from possible engineering solutions to industrial problems, present worth, annual cost, and rate of return techniques using discrete compound interest calculations. *Prep. Bachelor of Science degree in Engineering or Science.*

---

* Prerequisite course.

5.809 Advanced Engineering Economy
Principal emphasis on the practical application of the techniques studied in basic engineering economy; problems of implementation through class discussion of cases and student project; recent advances in the techniques of engineering economy, especially those relating to the consideration of uncertainties. *Prep. 5.808, Basic Engineering Economy or equivalent.*

***5.810 Industrial Accounting for Engineers**
Introduction of basic accounting principles and procedures; use of accounting data as a management tool; a practical covering of basic cost accounting procedures related to materials, labor, and manufacturing expense cost control; job order, process, and standard cost systems. *Prep. Bachelor of Science degree in Engineering or Science.* Offered alternate years with 5.805.

5.811 Cost Accounting for Engineers
Cost accounting procedures as established by accountants are studied and evaluated in terms of being considered by the engineer for cost determination of alternative engineering proposals. *Prep. 5.810, Industrial Accounting for Engineers or equivalent.*

5.812 Managing Professional Personnel
The science and art of managing creative people employed in research, developmental, and engineering activities are considered with a view to understanding the problems encountered by such people and their managers in the course of their professional work. Attention is devoted to some behavioral theories and their applications in the practice of management. Emphasis is placed on each student's own experiences as professionals or managers in diverse industrial settings. Interactive considerations of problems encountered by the students on their jobs provide case studies for analysis by the class and bases for further insights to the practices of managing professionals in several fields of endeavor. *Prep. Bachelor of Science degree in Engineering or Science.*

5.813 Engineering Communication
Exploration of practice in the effective preparation and presentation, both written and oral, of the results of engineering projects and programs as a basis for business decisions: including formal reports, progress summaries, memoranda, and technical papers. The effective use of various media and audiovisual aids based on both audience and material. *Prep. Bachelor of Science degree in Engineering or Science.*

5.814 Development of Engineering Managers
Analysis of the problems faced by the engineer in the transition from individual contributor to engineering manager; the challenge of engineering management; integrating professional and management objectives; developing guides for engineering managers to examine their own work and performance and to improve their effectiveness as well as develop managerial skills in their subordinates. *Prep. 5.801, Analysis of the Industrial Enterprise I.*

5.816 Industrial Psychology for Engineers
A general coverage of the application of psychology to industry with emphasis on industrial environments and organization, human relations, group dynamics, tests and measurements, personnel practices, training, and motivation. *Prep. Bachelor of Science degree in Engineering or Science.*

5.817 Advanced Work Design
Basic philosophies of work design; implementation of work design concepts with case studies; study and analysis of models such as work sampling, sequence or flow of work models; repetitive and nonrepetitive work models, and work measurement models such as standard data; human factors in measuring operator performance; regression analysis approaches; emphasis on development of professional, analytical, and managerial skills and abilities at a systems level. *Prep. Bachelor of Science degree in Engineering or Science.*

5.819 Human Factors — Sensory/Motor
Design of equipment and systems for human use; emphasis on the application of engineering psychology; visual and auditory presentation of information — human information processing and skilled task performance — compatability and equipment design. *Prep. 5.851, Introduction to Human Factors Engineering or equivalent.*

5.820 Personnel Administration for Engineers
Personnel programs for attracting and retaining technical talent; evaluating effectiveness of major personnel policies including relations with organized labor; modern methods of salary and wage administration; planning profitable relationships among company, supervisors, and employees. *Prep. Bachelor of Science degree in Engineering or Science.*

5.822 Product Design and Value Analysis
Study of design parameters and their effect on development, manufacturing and procurement; functional analysis of components and systems; complete projects and case studies are integrated in the course. *Prep. Bachelor of Science degree in Engineering or Science.*

5.823 Production Analysis (4 q.h. credits)
Study of advanced problem-solving techniques in the areas of method and measurement, layout and facilities planning, material handling and manufacturing process. Case studies and a course project in a local concern illustrate the concepts presented. *Prep. Bachelor of Science degree in Engineering or Science.*

5.824 Case Studies in Industrial Engineering
Formulation of problems and analysis of situations on topics such as: work measurement, line balancing, plant layout, regression analysis, wage and salary administration, management information systems and network analysis. Class discussion and written analysis of a variety of cases is included. *Prep. 5.823, Production Analysis.*

5.830 Financial Management I
Study of the issues and processes of short-term financing of industrial firms; financial analysis of cases, supplemented by readings to develop familiarity with sources and uses of working capital as well as the goals and problems involved in its management. (Open to Engineering Management majors only.) *Prep. 5.801, Analysis of the Industrial Enterprise I, and 5.810, Industrial Accounting for Engineers, and 5.808, Basic Engineering Economy or equivalent.*

5.831 Financial Management II
Extension of Financial Management I with emphasis on analysis necessary to such long-term financial decisions as issuance of stock or bonds; contracting of leases or loans,

and financing of a new enterprise; mergers, capital budgeting, the cost of capital, and the valuation of a business. *Prep. 5.830, Financial Management I.*

5.841 Engineering Project Management
Principles and practices of managing engineering projects in the complex environment of rapid technological advance, stiff competition, adverse economic conditions, ever-changing governmental regulations, and the constraints of corporate operating policies are considered with a view to acquiring deeper insights to achieving personal and company objectives while meeting contractual commitments. Particular emphasis is placed on planning the effort, organizing and integrating resources, measuring results, understanding proposal requests, writing winning proposals, understanding and meeting contractual requirements, negotiating contracts and changes therein, developing personnel as well as fulfilling entrepreneurial goals. *Prep. 5.812, Managing Professional Personnel, or 5.814, Development of Engineering Managers, or department permission.*

5.851 Introduction to Human Factors Engineering
A survey of the principal topics and areas of concentration in the field. Includes introductory concepts of sensory physiology and sensory performance; basic motor capabilities and limitations; concepts of the human as a processor of information; and methods of gathering human performance data. Normally the first course in the human factors area for students without behavioral science background. *Prep. Statistics II or permission of instructor.*

5.852 Human Factors — Work and Environment
Focuses upon the human as a work-performing, heat-generating physiological engine. Examines the implied restrictions upon equipment and work place to provide occupational safety and effective man/machine performance. *Prep. 5.851, Introduction to Human Factors Engineering or equivalent.*

5.853 Man-Computer Interaction
Design and evaluation of the man-computer interface in on-line information systems: formatting of visual displays and auditory outputs, techniques to facilitate operator inputs, pacing and control of the interactive sequence, operator training, task analysis and performance testing. Student projects in areas of novel application. *Prep. 5.819, Human Factors, — Sensory/Motor.*

5.854 Human Factors Engineering — Data Base
The study of methods and techniques used to obtain and interpret human performance data. Includes examination of experimental methods and problems peculiar to experimentation with human subjects; unobtrusive measures, and non-reactive techniques, survey design and implementation, and systematic observation techniques. *Prep. 5.964, Design of Experiments I.*

5.855 Human Factors Engineering — Application Methods
Systems analysis and man/machine systems; function and task analysis, task allocation, support equipment and training design, error analysis. Occupational safety; preconstruction, periodic; and accident/critical incident analytic techniques. *Prep. 5.851, Introduction to Human Factors Engineering or equivalent.*

5.862 Introduction to Occupational Health and Safety
Accident prevention, accident cost analysis, Federal and local legislation, record keeping requirements under OSHA Act of 1970; occupational safety and health standards, safety

programs and inspections, fire prevention and control methods; human behavior and industrial safety, occupational diseases and personnel protective equipment. *Prep. Bachelor of Science degree in Engineering or Science.*

5.863 Technical Aspects of Health and Safety
Safety responsibilities of management and employees; methods of hazard control; accident investigation; recognition of chemical, electrical and mechanical hazards; principles of machine guarding; occupational safety and health standards, safety training; toxology and first aid and medical services. *Prep. 5.862, Introduction to Occupational Health and Safety or permission of the instructor.*

5.864 Topics in Physiology and Biomedical Engineering
Introduction to specific areas relating to human structure and function, and to the use of engineering techniques for medical diagnosis and therapy. Areas considered include blood and blood components, the cardiovascular system, the kidney and urinary systems and respiratory systems. The course will be taught on a seminar basis. Students will be required to do literature research under the guidance of the instructor. *Prep. Permission of instructor.*

***5.900 Basic Operations Research** (4 q.h. credits)
An introduction to the theory and use of deterministic and stochastic models to represent industrial operations. Models included are those of linear programming, dynamic programming, inventory control, waiting lines, and Monte Carlo simulation. Embodies the material in 5.901 and 5.902, Basic Operations Research I and II. Open to both day and evening students. *Prep. 5.962, Statistics I or 10.8G1, Probability.*

***5.901 Basic Operations Research I**
Introduction to the theory and use of deterministic models to represent industrial operations; includes linear programming, dynamic programming, networks, and game theory. *Prep. Bachelor of Science degree in Engineering or Science.*

***5.902 Basic Operations Research II**
Introduction to the theory and use of stochastic models to represent industrial operations; includes queuing, inventory, and Markovian models. *Prep. 5.901, Basic Operations Research I and 5.962, Statistics I or equivalent.*

5.903 Inventory Control and Production Planning
The design and operation of inventory systems from a scientific management point of view, including both required theory and practical aspects. Subjects include inventory control models, statistical forecasting, production scheduling techniques, distribution systems, management control and reports, discussion of actual systems, and a case study. *Prep. 5.963, Statistics II or equivalent.*

5.904 Queuing Theory and Its Applications
A development of the theory of queues with emphasis on practical applications, using the latest techniques of Markovian state-transition diagrams to simplify the mathematic

---

* *Prerequisite course.*

model; study of models based on random arrivals and departures including exponential and Erlang service distributions, single and multiple services, series and parallel systems, finite and infinite queues; applications to staffing, inventory control, reliability, maintenance and scheduling. *Prep. 5.900 or 5.902, Basic Operations Research II.*

5.905 Analysis with Simulation
Appropriate utilization of simulation as an effective quantitative analysis technique. Course covers when, where, and how to use discrete event simulation techniques. Topics include model design, development and validation, as well as tactical and strategic planning considerations in the use of the model to evaluate alternatives. Several special purpose simulation languages are discussed with emphasis and practical exercise using GPSS. Applications are drawn from both production and service industry settings. *Prep. 5.913, Data Processing for Engineers, 5.962 Statistics I (formerly Probability and Statistics III), or equivalent.*

5.906 Principles of Dynamic Systems I
Introduction to modeling of social systems, emphasizing the study of feedback structures and their behavior; development of concepts that allow one to understand the mechanisms underlying growth, stagnation and cyclical fluctuation; examples and practice at formulating models of industrial, economic, social, and ecological systems; study of some of the effects of delays, multiple feedback loops, and nonlinearities; aim to building an intuitive foundation for simulation studies of complex systems. *Prep. Bachelor of Science degree in Engineering or Science.*

5.907 Principles of Dynamic Systems II
Continuation of topics from 5.906 with increased experience in the construction and analysis of generic feedback structures; examination of current and previous System Dynamics applications including Urban Dynamics and World Dynamics; exercises in model conceptualization. *Prep. 5.906, Principles of Dynamic Systems I.*

5.909 Systems Engineering and Analysis
Principles of systems modeling using a transfer function approach; transient response and sensitivity of open and closed-loop systems; stability analysis; frequency response. Emphasis is on the most recent time-domain analysis methods using state-transition diagrams, and solving by computer using readily available computer algorithms. *Prep. 5.913, Data Processing for Engineers.*

5.911 Linear Programming
An in-depth development of the theory in formulating the linear programming model for solving the problems of resources allocation, blending of ingredients, cutting stock, and flow-network commonly found in industry; sensitivity analysis, duality theorem, fundamentals of integer programming. *Prep. 5.900 or 5.902, Basic Operations Research II or equivalent and a course in linear algebra.*

5.912 Network Planning and Control
Applications of stochastic networks to project management, scheduling, inventory, reliability, quality-control and other industrial applications; review of PERT and its inadequacies, to the development of stochastic flow-graphs and networks; solving for the mean task times and variances using moment-generating functions; setting up the model for computer simulation using GERT. *Prep. 5.962, Statistics I (formerly Probability and Statistics III).*

***5.913 Data Processing for Engineers**
Open only to students who have not had a basic course or extensive experience in a compiler language. A study of digital computers and computer programming techniques as applied to management problems. The course will cover the basic characteristics and operation of computing equipment and peripheral devices. The FORTRAN language is presented in depth and will be utilized by the student for programming and running several projects on a computer. Other compiler languages will be described and compared to FORTRAN. A systems approach to the design, development, and implementation of computer programs for solving management problems will be emphasized. Examples will be studied from several management areas. *Prep. Bachelor of Science degree in Engineering or Science.*

5.914 Advanced Operations Research (4 q.h. credits)
Further study of quantitative techniques available to assist management in scientific decision-making, including Markov processes, utility theory, Bayesian statistics, and forecasting; case studies of real industrial problems. *Prep. 5.900, Basic Operations Research.*

5.916 Engineering Analysis Utilizing Data Processing
Application of computers and major high-level computer languages to the solution of engineering problems. FORTRAN and GPSS are employed in applications drawn from production and service-oriented industries to illustrate topics such as generation of random numbers, inventory simulation models, file search and sorting techniques, and root-finding algorithms. The standard software packages of SPSS and MPOS are introduced. *Prep. 5.913, Data Processing for Engineers, or equivalent.*

5.918 Applied Topics in Operations Research
Selected applications from the material covered in 5.901 and 5.902. *Prep. 5.901 and 5.902, Basic Operations Research I and II.*

5.919 Independent Study in Operations Research
Special topics in Operations Research by arrangement with a faculty member.

5.920 Elements of Structured Programming
An introductory course to the principles and techniques of top down structured programming. The host language is PASCAL and topics covered include assignment statements, logical expressions, control statements, data structures, recursion and pointers.

5.930 Basic Computer Systems Technology
Introduction to computer systems and assembly language programming using a language such as MIX. Topics include: machine language, assemblers and compilers. Input/output device control. List processing, searching, and sorting; file systems and storage management. Students are required to prepare and test several programs. The emphasis is on basic concepts necessary to understand and evaluate technological development. *Prep. 5.913, Data Processing for Engineers.*

---

* *Prerequisite course.*

5.931 Compiler Design I
An introduction to data structures including stacks and trees. The nature of compiling and interpreting, string manipulation and code generation. The writing of a compiler in assembly language of a BASIC-like source language will be started. *Prep. 5.930, Basic Computer Systems Technology, or consent of instructor.*

5.932 Compiler Design II
The Compiler design work started in 5.931 is completed as a term project. *Prep. 5.931, Compiler Design I.*

5.933 Data Structures for Information Systems
Treats the topics of computer files, file organization and processing, list and tree organization, maintenance controls, for quality, protection and security. *Prep. 5.940, Basic Information System Technology.*

5.934 Data Base Management
Introduction to data base systems and their rise in corporations. Review of basic data storage concepts. Evolution and growth of data bases. Data organization, file creation and management using hashing, threaded lists, tree structures. Distributed data bases. Data base software, directory maintenance, types of data base languages, query languages. Data base management systems. Data base administration. *Prep. 5.933, Data Structures for Information Systems, or equivalent.*

5.936 Simulation Methodology
Consideration of concepts in modeling, input data reduction, alternative programming languages for implementing models, model validation, efficiency in running simulations, and statistical reliability in the design and analysis of simulation experiments. Topics covered include: alternative approaches for simulation model control and their associated programming languages (e.g. SIMSCRIPT, GASP, and GPSS); parametric and nonparametric statistical techniques for reduction of empirical data to appropriate form for model input and validation; tactical planning issues such as selection of initial conditions, variance reduction techniques, and efficient generation of random variates; and design and analysis of experiments with underlying assumptions appropriate to the simulation process. Computer exercises illustrating the theoretical concepts will be drawn from production and service-oriented industries. *Prep. 5.905, Analysis with Simulation.*

5.938 File Processing
Processing of sequential, indexed-sequential, and direct/relative data files on tape and disk; record blocking, searching, sorting, and merging operations; random access techniques; introduction to data base management concepts, and if time permits an introduction to RPG. *Prep. 5.939 or ability to program in COBOL.*

5.939 Principles of COBOL
Fundamentals of computer programming in COBOL. Topics include elementary computer functioning, program organization, input/output operations, arithmetic and data-handling verbs, and program logic development through the use of flow charts. Storage and manipulation of large data files on magnetic tape are introduced. No prior computer experience is required.

5.940 Basic Information System Technology
Introduction to the hardware and software which support computer-based management information systems, design, development, and operation. Topics include basic computer concepts such as binary number systems, and CPU instruction cycle; data conversion and data entry devices; secondary memory types; output and display devices; and the nature of machine-oriented and high-level computer languages. Objective of the course is to provide sufficient knowledge regarding these concepts and equipment characteristics to permit specification of software and equipment configuration appropriate to support a given set of management information needs. *Prep. Bachelor of Science degree in Engineering or Science.*

5.941 Management Information Systems
The development of a conceptual framework which emphasizes support to management decision making. Relevant cognitive and organizational characteristics of human decision making are integrated into a systems analysis approach to development of effective information systems. Case study discussions are used extensively to apply principles to realistic situations. *Prep. Bachelor of Science degree in Engineering or Science.*

5.942 MIS: Planning, Control and Development
Phases of MIS design and development are examined from a planning and control viewpoint. Techniques are presented for conceptual identification of a continuing stream of information system candidate projects, for achieving a user-oriented assessment of cost/benefit potential, and for control of the design and implementation effort. Case study discussions are used extensively to apply principles to realistic situations. *Prep. Bachelor of Science degree in Engineering or Science.*

5.943 Distributed Data Processing
Develops the trade-offs in performance between centralized systems utilizing large-scale hardware installations and distributed systems utilizing minicomputers. Trade-offs are in terms of MIS performance capabilities, software development costs and lead times, management control, documentation and maintenance times and cost. Discussion of hardware is at the conceptual level of data flow and processing performance. *Prep. 5.940, Basic Information System Technology.*

5.944 Computerized Financial Control Systems
Considers on-line systems for financial and inventory control from the technological, legal, and social point of view. The focus of the course is on electronic funds transfer (EFT) and point of scale (POS) terminals and associated computing equipment for inter-bank and consumer banking transactions, debit card transactions, and retail management information systems to control cash and inventory. The current technological status of EFT and POS terminals is discussed, including computing equipment and data communications systems, system development time and cost, and data base security precautions. A significant portion of the course attempts to establish a prognosis for the use of EFT and POS terminals by assessing the opinions of principal figures and organizations in banking and retail, sometimes using guest lecturers. *Prep. 5.940, Basic Information System Technology.*

5.945, 5.946 Operating Systems and System Software I and II (2 courses, 2 quarter hours each)
A study of the components of operating systems including resource allocation management, multitasking, scheduling and I/O. Major software elements of a computer system

are considered, including loaders, linkers, assemblers, compilers and interpreters. *Prep. Knowledge of assembly language; 5.933, Data Structures for Information Systems; 3.972, Digital Computer Design I-A.*

5.947 Principles of Software Design
Examines techniques for solving complex computer programming tasks with special attention to the technological and organizational factors affecting information system building. Topics include run-time structures in programming languages, communication, linking, and sharing of programs and data; also, interface design, program documentation, maintenance modification, testing and debugging. Current topics in program design such as readability, data abstraction, step-wise refinement and structured program are also covered. *Prep. 5.945 and 5.946, Operating Systems and System Software I and II.*

5.948 Information Systems and Society
Discussion of the role computer systems play in modern society. The beneficial use of computers in commercial and industrial enterprises is considered and contrasted with the potential for infringement of individual privacy rights. Sufficient technical material on computer hardware, software, and data communications is discussed to permit assessment of system feasibility. Relevant major legislation is related to current practice in use of computer systems.

5.953 Statistical Decision Theory
Use of Bayesian statistical inference to arrive at decisions when stochastic variables are interacting; relationship to game theory; decision making over time in a sequence; important expected values and distributions; relationship of Bayesian decision theory to classical statistical inference. *Prep. 5.962, Statistics I (formerly Probability and Statistics III), or equivalent.*

5.954 Advanced Quality Control
Mathematical methods of quality control; development of the process control charts for sampling by variables and by attributes; development of acceptance test procedures; development of life-testing plans; cost aspects of quality-control decisions. *Prep. 5.962, Statistics I.*

5.955 Reliability Theory in Design
An introduction to the mathematical theory of the reliability of non-maintained systems and their application in the design of hardware and equipments in general; application of active and standby redundancy in systems; reliability predictions; stress-denoting techniques; availability concepts; design reviews and managerial control. *Prep. 5.962, Statistics I.*

5.956 Reliability and Maintainability Assessment
Engineering graphical and mathematical methods for reducing reliability test and field data; development and application of reliability and maintainability demonstration test plans and the economic aspects of each plan; maintainability predictions; managerial decisions. *Prep. 5.962, Statistics I.*

5.957 Reliability Analysis of Complex Systems
A Markovian-chain state-transition diagram approach to reliability modeling of non-maintained and maintained systems which permits analytic steady-state and dynamic solutions

of both the stationary and non-stationary models; setting up the matrix-equations for solution by computer; controlling the numerical oscillations and accuracy of the results. *Prep. 5.955, Reliability Theory in Design.*

***5.960 Probability I**
Fundamental concepts of probability. Events, event space, sample space, sampling. Axiomatic development events and the algebra of events. Counting, permutations, combinations. Discrete and continuous random variables. Density functions, mass functions, cumulative probability distributions. Expectation of random variables. Common discrete and continuous probability distributions including binomial, poisson, geometric, uniform, exponential and normal. *Prep. Admission to program.*

***5.961 Probability II**
Continuation of 5.960. Multivariate probability distributions, marginal and conditional distribution. Expected value of functions of random variables, variance, covariance, and independence of random variables. Common multivariate distributions including the multinomial and the multivariate normal. Methods of determining the probability distributions of functions of random variables are discussed. *Prep. 5.960, Probability I.*

***5.962 Statistics I**
Basic tools of statistical inference are covered. Limit theorems to include central limit, Chebyshevs Inequality, law of large numbers, point and interval estimators. Properties of estimators — bias, sufficiency, variance. Estimation by moments, max likelihood, Bayes. Hypothesis and hypothesis testing. One- and two-sided tests. Type I and Type II error. Power curve. *Prep. 5.961, Probability II.*

5.963 Statistics II
Extensions of topics covered in 5.962 to develop more complete statistical models for prediction and analysis of random phenomena. Topics include multiple regression analysis, correlation, design and analysis of simple experiments, and nonparametric tests such as goodness of fit and contingency tables. *Prep. 5.962, Statistics I.*

5.964 Design of Experiments I
An introduction to the theory and application of experimental design techniques such as modeling and statistics can optimize resources and improve decision making risks. This course will cover experiments with single and multiple factors of interest and consider restrictions imposed by various experimental conditions. *Prep. 5.962, Statistics I.*

5.965 Design of Experiments II
A continuation of topics from 5.964 including further design techniques to handle experiments with higher order experimental restrictions. Some additional analyses techniques will also be covered. *Prep. 5.964, Design of Experiments I, or equivalent.*

*** 5.966 Probability and Statistics** (4 q.h. credits)
Same material as 5.960 and 5.961 but offered as a 4 q.h. course.

---

* *Prerequisite course.*

5.991 Thesis (Master's Degree) (6 q.h. credits)
Analytical and/or experimental work conducted under the auspices of the department. *Prep. Consent of adviser.*

5.992 Seminar in Industrial Engineering
Discussion and presentations of thesis related topics by students, presentations and discussions by faculty and eminent people in the field on timely industrial engineering topics. Field trips and visitations included where appropriate.

5.993 Special Project in Industrial Engineering (2 or 4 q.h. credits)
Individual work under faculty supervision. *Prep. Consent of adviser.*

5.994 Industrial Engineer Degree Project (10 q.h. credits)
Undertaken with the approval of the candidate's adviser and the Department Graduate Committee.

INTERDISCIPLINARY COURSES

BIOMEDICAL

93.901 Engineering and Medicine I
The intersection of technology with medicine; historical development of bioengineering profession; its impact on society; study of activities embraced by the profession today; educational, training, and career opportunities in clinical, biomedical, and medical engineering for individuals at the BS, MS, and Ph.D. levels; future goals of engineering in biology and medicine; and issues basic to the relationship between new medical technology and the efficiency and effectiveness of the health care system. *Prep. Bachelor of Science in Engineering or allied field.*

93.911 Biomedical Applications of Heat and Mass Transfer
Bioheat equation; thermal transport in living systems, thermal properties; thermal techniques in the measurement of blood flow; applications of heat transfer in medicine including hyperthermia for cancer therapy, hypothermia for tissue and organ preservation and cryosurgery, thermal sources for implantable artificial heart; and thermography in cancer detection. *Prep. Bachelor of Science in Engineering or allied field.*

93.912 Selected Topics in Bioengineering
Study of biomedical engineering appropriate to topics selected from fields of biomaterials, nuclear medicine, radiation diagnosis and therapy, biological transport processes, artificial organs, rehabilitation engineering, and microprocessor based clinical instruments. Introduction to medical technology assessment. *Prep. 93.901 or permission of instructor.*

TRANSPORTATION

93.818 Special Topics of Transportation (2 q.h. credits)
An individual effort in an area selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

93.819 Master's Report Transportation (4 q.h. credits)
An individual effort consisting of laboratory and/or literature investigation and analysis or advanced design of a project in an area of transportation selected by student and adviser resulting in a definitive report. *Prep. Permission of the Civil Engineering Department.*

93.820 Thesis (Master's Degree) (8 q.h. credits)
Analytical and/or experimental work conducted by arrangement with and under the supervision of the department. *Prep. Permission of the Civil Engineering Department.*

mathematics and physics

For mathematics and physics courses consult the bulletin of the Graduate School of Arts and Sciences.

the governing boards and officers of the university

July 1982

THE CORPORATION

Julius Abrams
William T. Alexander
William F. Allen, Jr.
* *Diana J. Auger

*Vincent Barletta
Allen G. Barry
Lincoln C. Bateson
*Roy H. Beaton
†F. Gregg Bemis
Beverly Ann Bendekgey
Robert P. Berkowitz
Alfred M. Bertocchi
Gerald W. Blakeley, Jr.
S. Whitney Bradley
Melvin B. Bradshaw
Rexford A. Bristol
Edward W. Brooke
*Frederick L. Brown
†George R. Brown
William L. Brown
William H. Bruce, Jr.
John L. Burns
Hyman H. Burstein
Victor C. Bynoe

*Louis W. Cabot
*Norman L. Cahners
*Thomas E. Cargill, Jr.
*Richard P. Chapman
Richard P. Chapman, Jr.
Robert F. Chick
Vessarios G. Chigas
Logan Clarke, Jr.
Livingstone N. Coakley
*David H. Cogan

Abram T. Collier
T. Paul Connolly
James J. Costello
Edward Creiger
H. James Crossan, Jr.

Roger C. Damon
Nelson J. Darling, Jr.
Dr. Melanie Dean
(Melanie C. Berger)
Virginia Schenkelberger
Devine
William O. DiPietro
Alfred di Scipio
Mrs. Estelle Dockser
Dorothy Dodge
* *William R. Driver, Jr.

William S. Edgerly
*William Elfers
*Byron K. Elliott
*William P. Ellison
Robert Erickson

*Frank L. Farwell
Joseph D. Feaster, Jr.
*James V. Fetchero
*Eldred L. Field
Phil David Fine
Joseph F. Ford
Albert S. Frager
Brenda J. Furlong

Murray J. Gart
Paul W. Glennon
*Lloyd S. Glidden, Jr.

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

John L. Grandin
* *Donald B. Guy

*Allan M. Hale
Edmund Blair Hawley
Rev. Michael E. Haynes
Donald P. Hearth
James S. Hekimian
William Hellman
*Ernest Henderson III
Joseph E. Heney
James S. Herbert
Arnold S. Hiatt
Richard D. Hill
Thomas Hollis, Jr.
D. Brainerd Holmes
Robert W. Holmes
Hartwell G. Howe
John S. Howe
Howard M. Hubbard
*Carl R. Hurtig

Richard P. Johnson
*Robert L. Johnson
*Henry C. Jones

*George S. Kariotis
Walter B. Kelley
†Mrs. John B. Kenerson
(Frances Comins)
Edward M. Kennedy
Fenton G. Keyes
Calvin A. King
†Asa S. Knowles
Harvey C. Krentzman

Mrs. William D. Lane
(Evelyn M.)
*John P. LaWare
*Joseph C. Lawler
Maurice Lazarus
Elma I. Lewis
*Kenneth A. Loftman
Edward A. Loring
*John Lowell
*Diane H. Lupean

*Roderick M. MacDougall
Robert C. Marini

Mrs. C. Charles Marran
* *Lawrence H. Martin
M. Dorothy Massey
*George J. Matthews
Walter E. Mattson
*J. Edwin Matz
Peter H. McCormick
William J. McCune, Jr.
John G. McElwee
Katherine Seay McHugh
Percy M. McIntosh
Dominic Meo, Jr.
William C. Mercer
Don G. Mitchell
Donald H. Moore
Frank E. Morris
James A. Morris
* *Stephen P. Mugar

N. Laurence Nagle
William H. Nichols, Jr.
Mrs. James Nicholson
(Kathryn A. MacKinnon)

Bernard J. O'Keefe
Stanley C. Olsen
James H. Orr
Ara Oztemel

*Augustin H. Parker
Edward S. Parsons
*Miss Amelia Peabody
Theodore R. Peary
Lawrence T. Perera
Nicholas V. Petrou
Edward E. Phillips
*Thomas L. Phillips
Edward D. Phinney
Rudolph F. Pierce
Jerome M. Powell
Albert Pratt
John F. Prendiville
Peter W. Princi
*William J. Pruyn
George Putnam

Blanche M. Quaid
*Francis J. Quirico

---

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

William H. Raye, Jr.
Dr. Kathleen M. Rice
D. Paul Rich
Robert Riesman
R. Earl Roberson
Daniel J. Roberts
†Dwight P. Robinson, Jr.
Ralph B. Rogers
Ronald L. Rossetti
*Kenneth G. Ryder

Ernest J. Sargeant
David T. Scott
Donald W. Seager
Sydney Shaftman
James L. Shanahan
Robert E. Siegfried
*Dorothy M. Simon
Philip A. Singleton
Paul D. Slater
* *Donald W. Smith
*Farnham W. Smith
*Mrs. Gordon Smith
(Charlotte B.)
*George A. Snell
O. Phillip Snowden
*Bernard Solomon
Robert C. Sprague

Milton Stern
David B. Stone
*Mrs. Harborne W. Stuart
(Ruth B. Storey)

H. Patrice (Kincade) Taylor
Lawrence I. Templeman
Charles H. Tenney II
Almore I. Thompson
Milton A. Thompson
W. Nicholas Thorndike
Alan D. Tobin
*D. Thomas Trigg
Paul E. Tsongas
Joseph F. Turley
†Chaplin Tyler

Samuel Wakeman
Martin F. Walsh
*An Wang
Lloyd B. Waring
James L. Waters
David T. Wendell
William C. White
*Robert H. Willis

Richard W. Young

* *Alvin C. Zises

---

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

OFFICERS OF THE CORPORATION AND BOARD OF TRUSTEES

Robert H. Willis, Chairman
Norman L. Cahners, Vice Chairman
Frank L. Farwell, Vice Chairman
Farnham W. Smith, Vice Chairman
D. Thomas Trigg, Vice Chairman–Finance
Philip C. Boyd, Secretary
Byron K. Elliott, Honorary Chairman
William R. Driver, Jr., Honorary Vice Chairman
Dwight P. Robinson, Jr., Honorary Vice Chairman

BOARD OF TRUSTEES

Class of 1982
Frederick L. Brown
David H. Cogan
Frank L. Farwell
Lloyd S. Glidden, Jr.
Allan M. Hale
Henry C. Jones
J. Edwin Matz
Farnham W. Smith
George A. Snell
D. Thomas Trigg

Class of 1983
Vincent Barletta
Roy H. Beaton
Louis W. Cabot
Byron K. Elliott
Kenneth A. Loftman
John Lowell
Roderick M. MacDougall
Augustin H. Parker
Francis J. Quirico
Mrs. Gordon Smith
(Charlotte B.)
An Wang

Class of 1984
Thomas E. Cargill, Jr.
Eldred L. Field
Robert L. Johnson
George S. Kariotis
Diane H. Lupean
Amelia Peabody
Thomas L. Phillips
William J. Pruyn
Dorothy M. Simon
Bernard Solomon
Robert H. Willis

Class of 1985
Norman L. Cahners
Richard P. Chapman
William Elfers
William P. Ellison
James V. Fetchero
Ernest Henderson III
Carl R. Hurtig
John P. LaWare
Joseph C. Lawler
George J. Matthews
Mrs. Harborne W. Stuart
(Ruth B.)

Ex Officio
††Kenneth G. Ryder

Honorary Trustees
Diana J. Auger
William R. Driver, Jr.
Donald B. Guy
Lawrence H. Martin
Stephen P. Mugar
Donald W. Smith
Alvin C. Zises

Lifetime Trustees, Emeriti
F. Gregg Bemis
George R. Brown
Mrs. John B. Kenerson
(Frances Comins)
Asa S. Knowles
Dwight P. Robinson, Jr.
Chaplin Tyler

††President of the University

ADMINISTRATIVE ORGANIZATION

Officers of the University

Arthur W. Brodeur, B.S., *Vice President for Public Affairs*

John A. Curry, A.B., Ed.M., Ed.D., *Senior Vice President for Administration*

Edmund L. Deltano, B.A., *Vice President for Finance*

Asa S. Knowles, A.B., A.M., LL.D., Litt.D., Sc.D., D.B.A., Sc.D. in Bus. Ed., *Chancellor*

Melvin Mark, B.S., M.S., Sc.D., *Senior Vice President for Academic Affairs and Provost*

John Martin, B.S., M.B.A., *Vice President for Business*

John D. O'Bryant, B.S., M.Ed., *Vice President for Student Affairs*

Eugene M. Reppucci, Jr., B.S., M.Ed., *Vice President for University Development*

Daniel J. Roberts, B.S., M.B.A., Ed.M., *Senior Vice President-Treasurer*

Kenneth G. Ryder, A.B., M.A., L.H.D., *President*

Royal K. Toebes, B.S., M.B.A., *Vice President for Alumni Development*

Roy L. Wooldridge, B.S., Ed.M., *Vice President for Cooperative Education*

Academic Deans, Directors of Schools, and General Administrative Officers

Richard Astro, B.A., M.A., Ph.D., *Dean of the College of Arts and Sciences*

Maryann G. Billington, A.B., M.B.A., *Assistant Dean and Director of the Graduate School of Business Administration*

David H. Blake, A.B., M.B.A., Ph.D., *Dean of the College of Business Administration*

Philip T. Crotty, A.B., A.M., M.B.A., Ed.D., *Vice Provost*

Martin Damian, B.S., *Bursar*

Charles Devlin, B.S., M.Ed., *Dean of Student Financial Services*

Theodore N. Ferdinand, B.S., M.S., Ph.D., *Director of the Graduate Program in Criminal Justice*

Clifford J. Fralen, B.S., M.S.E., M.B.A., *Director of the Physical Plant*

William A. Frohlich, B.A., *Director of University Publishing Group and Director of University Press*

Job E. Fuchs, M.D., *Director of Health Services*

Joseph M. Golemme, S.B., M.A., C.P.A., *Director of the Graduate School of Professional Accounting*

Thomas E. Hulbert, B.Mgt.E., M.S., *Director of Lincoln College and Associate Dean of Engineering*

Ellen S. Jackson, B.A., Ed.M., C.A.G.S., *Dean and Director of Affirmative Action*

John W. Jordan, B.S., M.Ed., *Dean of University College*

Paul M. Kalaghan, A.B., M.S., Ph.D., *Dean of the College of Computer Science*

Christopher F. Kennedy, A.B., Ed.M., *Dean of Administration*

Philip LaTorre, B.S., M.S., *Dean of Personnel Services and Director of Environmental Health*

Paul M. Lepley, B.S., M.Ed., Ed.D., *Dean of Boston-Bouvé College of Human Development Professions*

Juanita O. Long, B.S.N., M.S.N., C.A.G.S., *Dean of Nursing*

Harold Lurie, B.S., M.S., Ph.D., *Dean of Engineering*

Philip McCabe, B.A., M.Ed., *Dean of Admissions*

Michael C. Meltsner, A.B., LL.B., *Dean of the School of Law*

Roland H. Moody, A.B., B.L.S., *Director of the University Libraries*

Edmund J. Mullen, B.A., M.Ed., *University Registrar*

J. Edward Neighbor, B.S., M.S., Ph.D., *Director of the Graduate School and Associate Dean of the College of Arts and Sciences*

John L. Neumeyer, B.S. Ph.D., *Director of the Graduate School of Pharmacy and Allied Health Professions*

Paul M. Pratt, B.S., M.Ed., *Dean of the Department of Cooperative Education*

John G. Proakis, B.S., M.S., Ph.D., *Director of the Graduate School of Engineering and Associate Dean of Engineering*

Edward W. Robinson, B.S., Ed.M., *Dean of Students*

Norman Rosenblatt, A.B., Ph.D., *Dean of Criminal Justice and Director of the Graduate Program of Criminal Justice*

Jeanne L. Rowlands, B.A., B.S., M.A., *Director of Women's Athletics*

Gerald E. Schumacher, Pharm.D., M.Sc., Ph.D., *Dean of College of Pharmacy and Allied Health Professions*

Karl Weiss, B.S., Ph.D., *Vice Provost*

Joseph Zabilski, B.S., *Director of Men's Athletics*

GENERAL UNIVERSITY COMMITTEES

Academic/Administrative Council*

Kenneth G. Ryder, Chairman
John A. Curry, Vice Chairman
Melvin Mark, Vice Chairman
Barbara F. Burke, Secretary

Richard Astro
David H. Blake
Arthur W. Brodeur
Charles W. Coffin
Philip T. Crotty
Edmund L. Deltano
Clifford J. Fralen
Humberto F. Goncalves
Ellen S. Jackson
John W. Jordan
Paul M. Kalaghan
Christopher F. Kennedy
Roland E. Latham
Philip La Torre
Paul M. Lepley
Juanita O. Long
Harold Lurie
Kathryn Luttgens
John A. Martin
Philip R. McCabe
Michael C. Meltsner
Christopher Mosher
John D. O'Bryant
Donald G. Porter
Paul M. Pratt
Eugene M. Reppucci, Jr.
Daniel J. Roberts
Edward W. Robinson
Norman Rosenblatt
Gerald E. Schumacher
Arthur D. Smith
Royal K. Toebes
Karl Weiss
Roy L. Wooldridge

*Two faculty representatives to be selected by the Faculty Senate Agenda Committee.

The Faculty Senate

**Melvin Mark, Presiding Officer

George G. Adams
Samuel J. Bernstein
**David H. Blake
Franklyn K. Brown
Richard L. Canale
Holly M. Carter
Sangit Chatterjee
**John A. Curry
Arthur Davis, Jr.
Charles H. Ellis, Jr.
Steven E. Eriksen
Mary Florentine
Norbert L. Fullington
Harold M. Goldstein
Robert A. Gonsalves
Peter J. Graham, Jr.
Bart K. Gruzalski
Jessie L. Hansen
Jorge V. Jose
Maurice Kaufman
**Paul M. Kalaghan
Frank F. Lee
**Paul M. Lepley
**Juanita Long
**Harold Lurie
Bertram J. Malenka
Robert A. Millen
Stuart S. Peterfreund
Harlan D. Platt
**Paul M. Pratt
Donald J. Reaves
**Norman Rosenblatt
**Gerald E. Schumacher
Wallace W. Sherwood
Marilyn M. Smith
Michael R. Vaughn
Nancy Walden
Robert N. Wiener
John Zotos

**Appointed by the President

ORGANIZATION OF THE GRADUATE SCHOOLS

Administration

Linda J. Allen, M.Ed., Registrar of the Graduate Schools

Maryann G. Billington, M.B.A., Assistant Dean and Director of the Graduate School of Business Administration

Theodore N. Ferdinand, B.S., M.S., Ph.D., Director of the Graduate Program in Criminal Justice

Joseph M. Golemme, M.A., Director of the Graduate School of Professional Accounting

Deborah J. Hartry, M.Ed., *Assistant Director of the Graduate School of Arts and Sciences and Assistant Dean of the College of Arts and Sciences*

Thomas J. Kerr, M.S.I.E., Ph.D., Assistant Director of the Graduate School of Engineering

John C. Monks, J.D., Associate Dean of the School of Law

J. Edward Neighbor, Ph.D., Director of the Graduate School and Associate Dean of the College of Arts and Sciences

John L. Neumeyer, Ph.D., Director of the Graduate School of Pharmacy and Allied Health Professions

John G. Proakis, B.S., M.S., Ph.D., Director of the Graduate School of Engineering

Catherine H. Roach, B.A., *Associate Registrar of the Graduate Schools*

Janice Walker, A.B., Assistant Dean and Director of the Graduate School of Boston-Bouvé College of Human Development Professions

Karl Weiss, Ph.D., Vice Provost for Research and Graduate Studies

The Graduate Council

The Council determines broad policies and regulations governing the conduct of graduate work. All new graduate programs must be approved by the Council.

Officers

Karl Weiss, Chairman
Alfred Viola, Vice Chairman
M. Patricia Hinds, Secretary

Executive Committee

Alfred Viola, Chairman
Edith E. Flynn, Vice Chairwoman
Joseph E. Barbeau (pro tem)
David N. Brown
Colleen C. Pantalone
Joseph J. Zelinski

Elected Faculty Members

Reginald L. Amory
Petros N. Argyres
Joseph C. Aurelia
Joseph E. Barbeau, Director, Boston-Bouvé College of Human Development Professions
Maryann Billington, Director, College of Business Administration
Norman R. Boisse
David R. Brown
Conrad Caligaris
Bohumil Cenkl
Charles J. Collazzo
Romine R. Deming
Richard C. Deth
Angelo J. Fiumara
Edith E. Flynn
Thomas N. Ferdinand, Director, College of Criminal Justice
Janice L. Foster
Robert R. J. Gallati
W. Jay Gillespie
M. Patricia Golden
Bernard M. Goodwin
Peter J. Graham, Jr.
Thomas F. Henstock
Steward V. Hoover
Thomas J. Kerr, Acting Director, College of Engineering
Bruce M. Logan
James A. Lomastro
Harry A. Mackay
Roger Millen
J. Edward Neighbor, Director, College of Arts and Sciences
John L. Neumeyer, Director, College of Pharmacy and Allied Health Professions
Irene A. Nichols
Colleen C. Pantalone
Sandra M. Parker
John D. Post
William G. Quill
Ernest Ruben
Martin Schetzen
Fred N. Schneiweiss
Alfred Viola
Joseph Westlund
Joseph J. Zelinski

Committee on Graduate Study in Engineering

Bernard M. Goodwin, Chairman, *Associate Professor of Chemical Engineering*

John G. Proakis, Secretary, *Director of the Graduate School of Engineering and Professor of Electrical Engineering*

John W. Cipolla, *Professor of Mechanical Engineering*

Stewart V. Hoover, *Associate Professor of Industrial Engineering*

Thomas E. Hulbert, *Associate Dean of Engineering and Associate Professor of Industrial Engineering*

Martin Schetzen, *Associate Professor of Electrical Engineering*

Mishac K. Yegian, *Associate Professor of Civil Engineering*

Sidney F. Austin, *Ex Officio, Director of Career Development and Placement*

index

A

Academic calendar, 5
Academic/Administrative Council, 166
Address of University, 1
Administration
  University, 164
  Graduate Division, 167
Admission
  Doctor's degree, 26
  The Doctor of Engineering Degree, 28
  The Engineer Degree, 32
  Interdisciplinary Programs, 31
  Master's degree, 23
Appointments to fellowships, assistantships, 38

B

Board of Trustees, 163
Buildings, 14

C

Calendar, 5
Campus description and location, 14
Campus Map
  Boston, 4
  Burlington, 4
Center for Continuing Education, 10
Chemical Engineering, 75
Civil Engineering, 44
Class hours, 22
Committee on Graduate Study in Engineering, 169
Computer and Information Systems, 92
Computer Science, 68
Cooperative Plan of Education (see also fields of study), 17
Corporation members, 160
Courses, Description of
  Chemical Engineering, 141
  Civil Engineering, 97
  Electrical Engineering, 120
  Industrial Engineering, Engineering Management, and Information Systems, 147
  Interdisciplinary, 159
  Mathematics and Physics, 159
  Mechanical Engineering, 109

D

Degree programs, 9, 17, 25, 26, 28, 31, 32 (see also fields of study)
Doctor's degrees (see also fields of study)
  Admission, 20, 26
  Classification, 23, 28
  Comprehensive examination, 27, 29
  Course requirements, 23, 25, 27, 29
  Degree candidacy, 24, 26, 28
  Dissertation, 25, 27, 29
  Doctor of Engineering Degree, 26
  Final oral examination, 26, 27, 30
  Language requirements, 25, 27, 30
  Interdisciplinary programs, 31
  Qualifying examination, 25, 27, 29
  Registration, 28, 30
  Residence requirement, 25, 26, 29
  Time limitation, 25, 28
  Transfer credit, 25, 28

E

Engineer Degree, 32
Electrical Engineering, 63
Engineering Management, 82

F

Faculty, 40
Faculty Senate, 166
Fees, 35
Fellowships, 38
  Appointments to, 38
  Doctoral research, 39
  Research, 39
Fields of study
  Chemical Engineering, 75
  Civil Engineering, 44

Electrical Engineering, 63
Industrial Engineering, Engineering Management, and Information Systems, 82
Mathematics and Physics, 159
Mechanical Engineering, 56
Transportation, 94
Financial Information, 35

G

Grading System, 21
Graduate and Professional Schools, 9
Graduate School of Engineering
Fields of study, 44
Registration, 20
Regulations, 17

I

Industrial Engineering, Engineering Management, and Information Systems, 82
Interdisciplinary programs, 31
Admission, 31
Interdisciplinary Committee, 31

L

Loan program, 37

M

Map of campus, 4
Marine Science and Maritime Studies Center, 11
Master's degree (see also fields of study)
Academic classification, 23
Admission, 23
Comprehensive examination, 24
Thesis, 24
Time limitations, 25
Transfer credits, 25
Mathematics, 159
Mechanical Engineering, 56

P

Part-time programs (see also fields of study), 25
Physics, 159
Programs of study (see also fields of study), 20

R

Registration dates, 5
Regulations
For doctor's degree, 26, 28
For master's degree, 23
Graduate division, 17
Research activities, 10
Research fellowships, 39

S

Suburban Campus, 15

T

Tuition, 35
Transportation, Graduate Program in (Interdisciplinary), 94
Trustees, 163

U

University Graduate Council, 168

W

Withdrawals, 23

Northeastern University Publishing Group
September 1982

List other activities since high school. Include military service, but omit summer and part-time work not relevant to professional goal. Indicate present employer, if now employed.

Employer	Location	inclusive Dates	Position Held

Give the names and addresses of two people who are acquainted with your scholarship, training, and character.

Name	Address	Position

I hereby certify that the information given by me on this application is complete and accurate.

Applicant's signature _____ *Date* _____

The following should be on file in the Graduate School of Engineering for this application to be processed:

- Completed Application
- Official Transcripts
- Application Fee
- Other Documents as Required.

Do not write below this line.

Full-Time Students

Application Reviewed _____

Accepted _____

Admissions Committee Date

_____

Cooperetive Education Department, if necessary Date

Denied ☐

Reason:

Signed _____

Part-Time Students

Application completed _____

Transcript received _____ Requested _____

Accepted _____ Denied _____

Department _____ Major _____

Regular _____ Provisional _____

Specified _____ Unspecified _____

Special _____ Nondegree _____

Pre-graduate _____

Special Requirements:

Signed _____

Northeastern University
Graduate School of Engineering, Boston, Massachusetts 02115

ENG

Application for Admission

This application should be completed and returned to the Graduate School of Engineering. Students must request that **official transcripts of all college and university work** previously taken must be sent directly by the registrar of each institution attended. Students who have attended institutions outside the United States should provide comparable certified documents. Such transcripts, records, and any required **standardized test scores** should be sent to the above address. **This application cannot be considered until all these documents have been received. The $25 nonrefundable application fee must accompany the application. Make checks payable to Northeastern University.**

Date _____

Social Security Number _____

Name _____
Last First Middle

Present Address _____
Number and Street Home Phone (Area Code) Work Phone

_____
City State ZIP Code

Permanent Address _____
(if different) Number and Street Telephone (Area Code)

_____
City State ZIP Code

Graduate Department:
- Civil ☐
- Mechanical ☐
- Electrical ☐
- Chemical ☐
- Industrial ☐
- Engineering Mgt. ☐
- Information Sys. ☐
- Transportation ☐

Program
- Full Time
  - Cooperative Plan
    - Alternating ☐
    - Parallel ☐
  - Continuous
    - Full Time ☐
- Part Time ☐

Entering Quarter
- Fall ☐
- Winter ☐
- Spring ☐
- Summer ☐

Degree
- M.S. ☐
- Ph.D. ☐
- D. Eng. ☐
- Engineer Degree ☐
- Special ☐

Area of Concentration (Major): _____
(refer to catalog)

Date of Birth _____ Place of Birth _____

Citizenship _____ If not U.S., type of visa _____
(Country)

Permanent Resident No. _____

List in chronological order ALL colleges and universities attended, including professional schools:

Name and Location	Month and Year of Attendance	Major	Degree Received or Expected, and Date	Cumulative Grade-Point Average
	from to			
	from to			
	from to			

Academic Honors _____

Activities _____

_____

(over)

BOSTON-BOUVÉ COLLEGE OF HUMAN DEVELOPMENT PROFESSIONS

1981-1982
Graduate Programs
Northeastern University

BOSTON-BOUVÉ
COLLEGE OF
HUMAN DEVELOPMENT
PROFESSIONS

Graduate Programs

Northeastern University

102 The Fenway
Boston, Massachusetts 02115
Telephone: 617-437-2708

Contents

4 Introducing Boston-Bouvé College of Human Development Professions
4 Studying in the Graduate School
5 Programs of Study
8 Master of Education, Master of Science, and Certificate of Advanced Graduate Study Programs
8 General Information
12 Program Descriptions
32 Doctor of Education Programs
32 General Information
36 Program Descriptions
37 Financial Information
40 General Regulations
44 The University
45 Graduate and Professional Schools
46 Department Directory
47 Campus Map
48 Academic Calendar
48 University Holidays
51 Governing Boards and Officers of the University

Introducing Boston-Bouvé College of Human Development Professions

The new Boston-Bouvé College of Human Development Professions was created in July 1980 when Northeastern University's Board of Trustees voted to approve a faculty-supported merger between the University's Boston-Bouvé College and the College of Education.

Ten separate departments are united by the merger. Each offers its own degree programs related to specialized and professional areas of study, but each shares with the other departments a common interest in educational service and a dedication to the concept of life-long education and the care and instruction of young and old, able and handicapped. For the ten departments brought together in Boston-Bouvé College of Human Development Professions, the merger expresses physically a unity that had always existed philosophically.

Studying in the Graduate School

The Graduate School of Boston-Bouvé College of Human Development Professions is one of eight graduate and professional schools at Northeastern. It offers more than seventy different programs of study leading to the master's degree, the certificate of advanced graduate study (CAGS), and the doctoral degree, all designed to help meet the needs and interests of professionals in a variety of educational, health-care, and community settings. In addition, the Graduate School offers nondegree certification and licensure programs in various teaching areas.

Students may enroll in Boston-Bouvé Graduate School on a full- or part-time basis, although international students on student visas must enroll full time. Part-time students usually elect one or two courses per academic quarter and can complete master's or CAGS requirements in two or three years. With careful planning, full-time students may be able to complete these same programs in one year.

Boston-Bouvé Graduate School schedules classes to offer students the maximum convenience and flexibility. Classes meet once weekly for twelve weeks in the fall, winter, and

spring quarters and twice weekly during the six-week summer quarter. All classes are scheduled during the late afternoon and evening hours or, occasionally, on Saturdays, at the main campus in Boston as well as at other accessible locations.

Programs of Study

The programs of study offered by the Graduate School of Boston-Bouvé College of Human Development Professions are listed below in alphabetical order according to degree. Some major areas of study permit students to select from concentrations within the area or to further specialize by pursuing study options available within concentrations. Where indicated by an asterisk (*), programs require the Miller Analogies Test (MAT) scores for admissions consideration; all other programs require the Graduate Record Examination (GRE) scores. Refer to the appropriate page(s) for specific information regarding individual programs.

Nondegree Certification Program
For elementary and secondary school teachers

Nondegree Licensure Programs
Moderate Special Needs
Severe Special Needs

Master of Education Programs
School and College Counseling
- Elementary School Counseling
- Secondary School Counseling
- Career Development and Cooperative Education
- College Counseling
- Industrial Counseling
- Student Personnel

Community Mental Health Counseling
Curriculum and Instruction
- Adult Literacy
- English-Language Arts
- General Academic
- Instructional Technology
- Reading
- Science-Mathematics
- Social Studies

Early Childhood Education
  Administration
  Teaching
Educational Administration
  School Administration
  Occupational and Career Education Administration
Educational Research
Human Development
*Rehabilitation and Special Education
  *Rehabilitation Administration
  *Rehabilitation Counseling (including specialization in Deafness)
  *Moderate Special Needs
    *Early Childhood Handicapped
  *Severe Special Needs
  *Special Education Community Personnel
Social Sciences
Speech-Language Pathology and Audiology
  Audiology
  Speech Pathology

Master of Science Programs

Physical Education
  Administrative and Curricular Studies
    Administration and Supervision
    Curriculum and Instruction
  Exercise Sciences
    Athletic Training
    Cardiovascular Health and Exercise
    Kinesiology/Biomechanics
  Movement Behavior
    Adapted Physical Education
    Sports Studies
    Motor Learning and Development
Physical Therapy
  Cardiopulmonary Physical Therapy
Recreation and Leisure Studies
  Recreation Management
  Therapeutic Recreation

Certificate of Advanced Graduate Study (CAGS) Programs

Counselor Education
  Pupil Personnel Services Administration
  School Psychology

Counseling
School
College
Community Mental Health
Family Systems Therapy
Curriculum and Instruction
Adult Literacy
English Education
English-Language Arts
Instructional Technology
Reading
Science-Mathematics
Social Studies
Educational Administration
Cooperative Education Administration
Higher Education Administration
Instructional Technology Administration
School Administration
Special Education Administration
*Rehabilitation
*Rehabilitation Counseling
Social Sciences

Doctor of Education Programs

Leadership: Administration and Supervision
Counselor Education
Pupil Personnel Administration
Student Personnel Administration
Educational Administration
Cooperative Education Administration
Higher Education Administration
School Administration
Special Education Administration
Rehabilitation Administration

Master of Education, Master of Science, and Certificate of Advanced Graduate Study Programs

General Information

Admissions

An applicant for the Master of Education or Master of Science degree or Certificate of Advanced Graduate Study must have earned a bachelor's or master's degree, respectively, from an accredited institution and complete all admissions procedures as described below.

The following material must be on file in the Boston-Bouvé Graduate School offices before consideration will be given to any application:

1. Complete application form
2. Official transcripts from all colleges or universities attended
3. Three references
4. Statement of goals
5. An official copy of the Graduate Record Examination (GRE) scores or, for applicants to programs offered by the Department of Rehabilitation and Special Education, a copy of the Miller Analogies Test (MAT) scores
6. For applicants whose native language is not English, an official copy of the results of the Test of English as a Foreign Language (TOEFL)

International students are also required to submit an Educational Chronology form and a Declaration and Certification of Finances form.

7. $25 application fee (nonrefundable)

Boston-Bouvé Graduate School may require a preadmission conference with any applicant.

The graduate school has a rolling admissions policy in most programs. Students may apply for admission in any quarter—fall, winter, spring, or summer—with the exception of applicants to programs in the Departments of Counselor Education (summer and fall only) and Speech-Language Pathology and Audiology (fall only).

The Admissions Office for Boston-Bouvé Graduate School is open Monday through Friday from 8:30 a.m. to 4:30 p.m. for personal interviews. Applicants wishing to discuss educational and career plans may call 617-437-2708 to make an appointment with the Coordinator of Admissions.

Special Departmental Admissions Requirements

Teacher certification is a prerequisite for programs in the areas of curriculum and instruction, early childhood education, school administration, and education for teachers of children with moderate special needs. Students not holding certification may enroll in a combined program.

Students applying to graduate programs in the areas of physical education, recreation and leisure studies, and speech-language pathology and audiology should have earned bachelor's degrees in the same area of study. Lacking this requirement or a specific number of courses in the area, students are expected to complete some undergraduate courses as specified by the individual department concerned.

Students applying to the program in physical therapy must have graduated from an undergraduate program approved by the American Physical Therapy Association.

Other special departmental requirements are discussed, where appropriate, in the information on specific departmental programs.

Full-Time Study

Full-time students must take a minimum of eight quarter hours of course work in all quarters. Enrollment in additional courses in any quarter must be approved by the student's adviser.

Part-Time Study

A part-time student may enroll in a maximum of two courses in any given quarter.

Special Students

Applicants who have earned a bachelor's degree from an accredited institution and do not wish to pursue a graduate degree may be accepted as special students. Applicants for special-student status must complete an application form and submit an official transcript indicating the highest degree earned together with a $25 nonrefundable application fee.

Special students are part-time students and may take no more than two courses per quarter.

Special students who are later accepted into degree programs in Boston-Bouvé Graduate School may apply a maximum of twelve credits earned in study as a special student toward

fulfilling degree requirements, provided the courses are applicable to their programs. Special students may be considered for degree programs only upon full presentation of application materials as described for master's degree or CAGS programs (page 8).

Time Limitations

Course credits earned in the program of graduate study or accepted for transfer are valid for a maximum of seven years from the time taken to completion of degree requirements.

Academic Requirements

Students must complete a minimum of forty-eight quarter hours of course work in order to qualify for the Master of Education and Master of Science degree or the Certificate of Advanced Graduate Study. Students are expected to maintain a B (3.000) average in their course work; only eight (8) quarter hours of additional course work, including repeated courses, may be allowed to satisfy the B (3.000) average required for the degree. Students who receive a grade of F or U in a course must make up the course according to their adviser's recommendation. In no case are students permitted to repeat a course more than once.

Basic M.Ed. Degree Requirements

One course in Research Design
Two courses, chosen from an approved list in consultation with an adviser
A minimum of three graduate courses offered outside the student's major department

Basic M.S. Degree Requirements

One course in Statistics
One course in Research Design
66.890 Thesis/Project I
66.891 Thesis/Project II

Qualifying and Comprehensive Examinations

Master's degree candidates may be required by a department to take a comprehensive examination. Unsatisfactory performance in such an examination constitutes grounds for withholding the degree.

CAGS students may be required to take a qualifying examination. Some CAGS students are required to satisfactorily complete a comprehensive examination in order to qualify for the certificate.

Transfer Credit

A maximum of twelve quarter hours (nine semester hours) of credit obtained at another institution may be accepted toward the master's degree and the certificate of advanced graduate study, provided that the credits are recommended for transfer by the student's adviser, consist of work taken at the graduate level for graduate credit at an accredited institution, carry grades of A or B, and have not been applied toward any other degree.

Students desiring transfer credit should petition the Director of Boston-Bouvé Graduate School, in writing, by completing the necessary form obtainable from the Graduate School office or the faculty adviser. The completed form must be submitted to the Director of the Graduate School together with an official transcript and an excerpt from the catalog describing the course(s) for which transfer credit is requested. No transfer-credit request form will be considered complete without the signature of the student's adviser or department chairperson. Grades on transfer credits may not be used for the purpose of obtaining the academic average necessary for completion of degree requirements.

Students are informed in writing when transfer credit is officially awarded.

Course Descriptions

Course descriptions are available in the academic departments and in the Graduate School office.

Programs in Counselor Education

The Department of Counselor Education offers master's degree and CAGS programs to students interested in working in schools, higher education, community mental health agencies, hospitals, and industry.

M.Ed. Programs
At the master's level, specialized fieldwork settings and course work enable students to concentrate in the areas of school counseling, college counseling, community mental health counseling, career development and cooperative education, student personnel services, or industrial counseling.

Sample Program
Basic M.Ed. Requirements

Department Core Course Requirements

53.800	Philosophical Foundations of Guidance and Human Services
53.801	Tests and Test Procedures
53.804	Counseling Theory and Process
53.805-6	Counseling Practicum

One of the following:

53.813	School Counseling Strategies
53.814	Vocational Counseling Strategies
53.815	Rehabilitation Counseling Strategies
53.816	Psychological Counseling Strategies

Specialization Core Course Requirements

School Counseling

53.810	Elementary School Guidance
53.802	Vocational Development and Occupational Information
53.824	Individual Intelligence Testing

College Counseling

53.814	Vocational Counseling Strategies
or	
53.816	Psychological Counseling Strategies
53.809	The College Student and The Campus

Career Development and Cooperative Education
- 53.802 Vocational Development and Occupational Information
- 53.814 Vocational Counseling Strategies

Student Personnel Services
- 53.809 The College Student and The Campus
- 53.814 Vocational Counseling Strategies
- 53.812 Seminar in Student Personnel Work

Community Mental Health Counseling
- 53.808 Group Counseling
- 53.811 Family and Parent Counseling
- 53.807 Organization and Administration of Guidance
- 53.818 Case Studies in Marriage and Family Counseling
- 53.821 Psychoeducational Prescriptions
- 53.830 Seminar in Contemporary Issues in Counseling
- 53.831 Advanced Group Counseling

Industrial Counseling
- 53.811 Family and Parent Counseling
  or
- 56.983 Rehabilitation of the Alcoholic and Drug Dependent

Three courses in human resource management

Department Electives (selected from Community Mental Health Counseling courses)

The Counseling Practicum sequence (53.805-6) is always specific to the particular concentration to which the student has been admitted. Including the concurrently required counseling course (53.804), the sequence is offered only on a sequential basis beginning in the fall quarter. Part-time students may not begin this sequence until their second year of study and must apply for practicum placement by April 1 of the spring preceding practicum placement. Field site supervisors have the option of accepting or rejecting recommended students for placement.

During their practicum year, students should expect to spend two days (twelve hours) weekly at their practicum sites between October 1 and June 15. With special permission, some students may be able to use their places of employment as practicum sites, provided arrangements for supplementary experience are made with their advisers.

CAGS Programs

CAGS programs in Counselor Education are available in the major areas of Pupil Personnel Services Administration, School Psychology, Counseling (School, College, Community Mental Health), and Family Systems Therapy (Modular Program).

Students whose master's program in counselor education lacked a practicum are required to take Counseling Practicum 53.805-53.806 in addition to the minimum course requirements described below. Students with master's degrees in fields other than counseling are required, if otherwise admissible, to make up a minimum of five courses from the master's program, generally requiring at least two years to complete CAGS requirements.

All CAGS Counselor Education students are required to complete a full year of advanced fieldwork in the area of their specialization: 53.840-1 Advanced Fieldwork. In addition, they must also take 53.838 Psychodiagnostic Measures and, with the exception of School Psychology majors, 53.834 Advanced Theories of Behavior Change, as well as specialization and elective courses. Pupil Personnel Services Administration students select specialized courses from the Departments of Counselor Education and Educational Administration.

The full programs for all CAGS candidates must be carefully planned in consultation with academic advisers before course registration.

Concentration in Family Systems Therapy (Modular Program)

Students interested in developing a specialized competence in family systems therapy should select the modular program option. An intensive six-course sequence, accompanied by two advanced fieldwork courses, it is designed to promote an in-depth understanding of general systems psychological concepts and procedures as they are employed in family therapy.

Course enrollments in this program are limited to eighteen students per module. Students are required to have significant experience in the counseling field in order to qualify for the program and must make a commitment for two consecutive years as part-time graduate students.

Concentration in School Psychology

Offered jointly by the Department of Counselor Education and the Department of Psychology in the College of Arts and Sciences, the CAGS program in School Psychology is designed

for students interested in careers as school psychologists. In accordance with present Massachusetts certification requirements, the program is structured to assist students in developing the professional competencies necessary for providing direct, specific, and practical assistance to students, classroom teachers, parents, and other school personnel. Course offerings reflect areas of study that include learning theory, counseling strategies and interviewing, psychodiagnosis, remediation, special education, curriculum, organizational development, school structure, psychopathology, and human development.

Applicants to the program are interviewed by members of both departments concerned and, in addition to meeting regular CAGS admission requirements, must have at least thirty-two quarter hours (twenty-four semester hours) of undergraduate work in psychology as well as a master's degree in a psychology-related field in order to be considered for the program. Students admitted to degree candidacy are assigned an adviser from either the Department of Counselor Education or the Department of Psychology to work with them in planning a program of study.

Two years of field experience as a school psychology trainee under the supervision of a certified school psychologist are required.

Sample Program

53.843-4	School Psychology Fieldwork
51.870	Developmental Reading and Writing
	or
51.871	Reading and Language Disabilities I
56.840	Psychology of Individuals with Special Needs
19.822-3	Psychopathology I and II
53.836	Psychodiagnosis with Children and Adolescents
53.821	Psychoeducational Prescriptions
53.820	Seminar in School Psychology

Personality and Development Courses (two)

Elective(s)

Programs in Curriculum and Instruction

The Department of Curriculum and Instruction offers master's degree and CAGS programs designed to help students meet certification requirements of the Commonwealth of Massachusetts. Appropriate for certified or experienced teachers who wish to study instructional leadership and curriculum development, the programs may also benefit individuals who wish to have the opportunity to expand their professional backgrounds in subject matter or teaching skills by completing advanced degrees in their own or related fields.

Individuals lacking undergraduate teaching degrees may wish to enroll in the Department's nondegree certification program to meet teacher certification requirements before continuing in a regular master's degree program.

M.Ed. Programs

Master's degree programs in Curriculum and Instruction are available in the following areas:

- Adult Literacy
- Early Childhood Education
- English-Language Arts
- General Academic
- Instructional Technology
- Reading
- Science-Mathematics
- Social Studies

Sample Programs

Basic M.Ed. Requirements

Curriculum and Instruction Core Courses

51.880	The Evolution of Curriculum Theory and Practice
51.881	Seminar in Curriculum: Alternative Designs (not required in Reading)

Specializations

Adult Literacy

51.870	Foundations of Reading
51.871	Reading and Language Disabilities I
51.872	Literature and Materials Seminar
51.920	Methods and Materials in Adult Literacy
51.923	Adult Literacy Clinic I
51.925	Adult Literacy Clinic II

Early Childhood Education

56.848 Early Childhood Learning Problems: Identification and Program Development

93.801 Seminar in Early Childhood Education Theory and Practice

93.802 Practicum in Early Childhood Education I

93.803 Practicum in Early Childhood Education II

53.804 Counseling Theory and Practice

53.811 Family and Parent Counseling

or

56.835 Socio- and Psychodynamics of Family Life

English-Language Arts

51.842 The English-Language Arts Curriculum

51.843 Literature in the English-Language Arts Curriculum

51.844 Writing in the English-Language Arts Curriculum

51.848 Language in the English-Language Arts Curriculum

51.849 Topics in the English-Language Arts Curriculum

General Academic

51.870 Foundations of Reading

51.871 Reading and Language Disabilities I

51.837 Curriculum Problems in Science and Mathematics Education

51.838 Seminar in Science and Mathematics Teaching

51.853 History and the Social Sciences in the School Curriculum

51.854 Social Science Materials Seminar

Instructional Technology

Courses selected in consultation with adviser

Reading

51.870 Foundations of Developmental Reading

51.871 Diagnosis and Remediation of Reading/Language Disabilities I

51.872 Literature and Materials Seminar

51.873 Clinical Practicum in Reading

51.874 Diagnosis and Remediation of Reading/Language Disabilities II

51.875 Field Practicum in Reading

51.877 Language and Reading

51.893 Seminar in Supervision of Reading/Instruction

Science-Mathematics

51.837	Curriculum Problems in Science and Mathematics
51.838	Seminar in Science and Mathematics Teaching
51.839	Implementing Change in Science and Mathematics Education

Social Studies

51.851	Seminar in Current Issues in the Social Studies
51.853	History and the Social Sciences in the School Curriculum
51.854	Social Science Materials Seminar

Electives (chosen in consultation with adviser)

Other Purposes

Students who wish to specialize in curriculum and instruction in a field not included in the above list have the opportunity to work with a faculty adviser who will assist them in developing an appropriate course of study drawn on offerings available throughout Northeastern's graduate schools.

CAGS Programs

The Department of Curriculum and Instruction offers two program options leading to the CAGS. Students who wish to study curricular and instructional alternatives and instructional supervision should select Option I, while students who want further study in their specialized areas and in the subject of instructional alternatives should select Option II, currently offered jointly with the Department of English in the College of Arts and Sciences.

Sample Programs

Option I

Curriculum and Instruction Core Courses

51.881	Seminar in Curriculum: Alternative Designs (51.880 Evolution of Curriculum Theory and Practice is prerequisite.)
51.882	Seminar in Instruction: Alternative Designs
51.883-4	Seminar in the State-of-the-Art and Field Project

Electives (chosen according to major area of study)

Electives (chosen in consultation with adviser)

Option II

Curriculum and Instruction Core Courses

51.882 Seminar in Instruction: Alternative Designs (51.800 Principles of Teaching, or equivalent, is prerequisite.)

51.883-4 Seminar in the State-of-the-Art and Field Project

Curriculum and Instruction Electives

English Courses (minimum of six)

Programs in Educational Administration

The school administrator occupies a highly strategic position for influencing the central functions of teaching and learning. To help improve the quality of educational leadership, the Department of Educational Administration offers preparatory and continuing graduate programs at the master's and CAGS level for students who are interested in careers in administration, leadership, and supervision in an educational setting.

M.Ed. Programs

Three distinct programs are available at the master's level in the field of educational administration: elementary and secondary school administration, administration of occupational and career education, and early childhood administration. Courses of study emphasize the roles of individuals in positions such as assistant principal, principal of a small school, department chairperson, special program director, or beginning administrator in an allied field.

Sample Program

Basic M.Ed. Requirements

Departmental Course Requirements

52.810 Leadership in Education, Part I

52.811 Leadership in Education, Part II

52.813 Instructional Leadership: Curriculum Development and Supervision

Specialized Courses in Area of Concentration

Administration of Secondary School

Administration of Elementary School

Administration of Early Childhood Education

Administration of Occupational and Career Education
Administrative Internship (in appropriate setting)

Electives

Satisfactory completion of an oral conference and a written final comprehensive examination are also degree requirements of this program.

CAGS Programs

At the CAGS level, five administrative programs are available to applicants who have demonstrated a strong background in the special field of study at the master's degree level. Options for concentration include Cooperative Education, Educational Administration, Higher Education, Special Education Administration, and Instructional Technology.

Sample Program

Departmental Core Courses

52.830 Current Issues in Administration
52.831 Innovation and Change
52.832 Process of Administration
52.865 Systems Theory in Education

Specialized Courses in Area of Concentration

Administration and Supervision of Special Education
Administration of Cooperative Education
Administration in Higher Education
Educational Finance
School Administration
School Community Relations
School Law
Administrative Internship (in appropriate setting)

Electives

Satisfactory completion of a written final comprehensive examination is a requirement of this program.

Programs in Foundations of Education

The Foundations of Education Department offers Master of Education programs in the areas of Human Development and Educational Research.

Human Development

The Human Development program is designed to provide opportunities for practicing and prospective educators and human

services professionals to expand their knowledge and understanding of human development in its psychological and social aspects. The program offers a theory background for persons teaching, or planning to teach, psychology and behavioral science in secondary and elementary schools as well as for persons dealing with varied client populations in health- and service-oriented or recreational agencies.

Sample Program
Basic M.Ed. Requirements

Human Development Requirements

50.806	Psychology of Learning
	or
50.811	Psychology of Thinking
50.810	Psychology of Personality
	or
50.805	Personality and Social Structure
50.808	Seminar in Child Development
50.809	Seminar in Adolescent Development
50.819	Theories of Developmental Psychology

Electives (Four courses, chosen in consultation with an adviser, which may include a thesis)

Educational Research

This program offers professional training for individuals who are interested in careers in government, industry, or educational agencies or who wish to prepare for further study at the doctoral level. It is designed to help students acquire the skills of competent researchers by helping them develop 1) an understanding of the nature and characteristics of educational and social quantitative research as it is carried out in research agencies; 2) a basic knowledge of research methodology and related theory enabling them to assist at all stages of such research; and 3) the technical skill to carry out independently the operational aspects of research.

The culminating component of the program is the planning, executing, and written summarization of research for a thesis, intended as a small-scale, but usually original, investigation into a problem in education or related fields.

Sample Program
Basic M.Ed. Requirements

Research Requirements

50.841	Introduction to Educational Statistics

50.842	Intermediate Educational Statistics
50.817	Advanced Research Design
50.847	Introduction to Computer Programming: FORTRAN IV
50.891	Thesis (equivalent to two courses)
	or
50.845-6	Independent Research Seminars I and II

Electives (three)

Programs in Physical Education

Students enrolled in Master of Science programs in Physical Education may select from three areas of concentration, each of which offers various options permitting further specialization. In addition to the basic M.S. requirements, students must complete twelve quarter hours within one of the three areas of concentration and twenty quarter hours of elective courses. Two of the five elective courses must be outside the basic area of concentration.

Concentration in Administrative and Curricular Studies

Graduate study within this concentration provides the opportunity for students who would like to study the concepts and techniques of efficient management as well as supervision and leadership strategies to design a program in *Administration and Supervision*. The *Curriculum and Instruction* option is designed to focus on curriculum and instruction theory, concepts of curriculum and instruction development, and evaluation theory. Students selecting this option within the concentration should be certified and have some experience as teachers of physical education.

Sample Program

Basic M.S. Requirements

Specialization Courses (12 q.h.)

62.810	Administration of Physical Education and Athletics
62.830	Curriculum Development in Physical Education
62.833	Applied Evaluation in Curriculum and Instruction
62.835	Seminar in Curriculum and Instruction
62.840	Advances in Instructional Concepts
62.872	Comparative Physical Education
66.805	Planning and Developing Facilities for Physical Education and Recreation

66.814 Supervision of Professional Personnel
66.886 Critical Thinking and Evaluation in Physical Education and Recreation and Leisure Studies

Electives (20 q.h.)

Concentration in Exercise Sciences

Students selecting this concentration have the opportunity to focus on the scientific bases for human motion with corresponding application in one of three options: Athletic Training, Cardiovascular Health and Exercise, or Kinesiology/Biomechanics.

The *Athletic Training* option offers a program of study in the care and prevention of athletic injuries, conditioning, and rehabilitation and includes the course work necessary for National Athletic Trainers Association certification as an athletic trainer. Undergraduate course work in adapted physical education and athletic training are necessary. (Required courses in this option: 62.857, 62.859)

Students selecting the *Cardiovascular Health and Exercise* option have the opportunity to develop expertise in assessing the physical fitness and cardiovascular health status of adults, prescribing exercise, and organizing and administering effective preventive health and exercise programs. (Required courses in this option: 62.855, 62.865, 62.866)

The *Kinesiology/Biomechanics* option focuses on the anatomical and mechanical phenomena which underlie human movement and is designed to assist students in learning a systematic approach to the analysis of motor skills activities and exercise programs. (Required courses in this option: 62.851, 62.852)

Sample Program

Basic M.S. Requirements

Specialization Courses (12 q.h.)

62.851 Anatomic Kinesiology
62.852 Mechanical Analysis of Sport
62.854 Physical Fitness Appraisal and Guidance
62.855 Exercise in Cardiovascular Health and Disease
62.857 Trauma Diagnosis and Treatment in Sport
62.859 Rehabilitation from Injury in Sport
62.865 Electrocardiography
62.866 Laboratory in Exercise Testing and Prescription

Electives (20 q.h.)

Special prerequisites apply to this program. See page 31.

Concentration in Movement Behavior

The focus of study in the Movement Behavior concentration may be in Adapted Physical Education, Motor Development and Learning, or Sports Studies.

The *Adapted Physical Education* option emphasizes practical and theoretical aspects of movement programs and their management for special-needs individuals. Students selecting this option should have undergraduate backgrounds in motor learning and development as well as in adapted physical education. (Required courses in this option: 62.842, 62.845)

Sports Studies focuses on the historical, philosophical, and psychosocial aspects of sport and physical education. (No specific specialization requirements)

The *Motor Learning and Development* option has as its focus the relationship between age changes and the development of movement control in normal, intact individuals. (Required courses in this option: 62.864, 62.884)

Sample Program

Basic M.S. Requirements

Specialization Courses (12 q.h.)

62.822	Problems in Contemporary Athletics for Men and Women
62.842	Physical Education for Students with Special Needs
62.845	Management of Adapted Movement Performance Programs
62.860	Early Childhood Motor Patterns
62.864	Perceptual Motor Development
62.870	Philosophies in Physical Education and Sport
62.880	Sociology of Sport
62.884	Movement and the Learning Process

Electives (20 q.h.)

Special prerequisites apply to this program. See page 31.

Programs in Physical Therapy

The programs in Physical Therapy address the need for clinical specialization within the field of physical therapy. Three areas of clinical specialty in physical therapy practice are covered in the range of program options designed to meet criteria recommended by the American

Physical Therapy Association. At present, the Department of Physical Therapy offers only the clinical specialty in Cardiopulmonary Physical Therapy. This option, however, is being augmented by the introduction of a Neurological Physical Therapy specialty in the fall of 1982 and an Orthopedic Physical Therapy specialty in the fall of 1984.

Students specializing in Cardiopulmonary Physical Therapy have the opportunity to develop a clinical expertise in the evaluation, treatment, and prevention of medical and surgical cardiopulmonary conditions.

Sample Program

Basic M.S. Requirements

Specialization Requirements

62.855	Exercise in Cardiovascular Health and Disease
64.813	Cardiopulmonary Pathophysiology
64.815	Cardiopulmonary Diagnostic Techniques
64.820	Cardiac Rehabilitation Programs Phase I and II
64.822	Pulmonary Rehabilitation Programs
64.825	Conditions of Cardiac and Pulmonary Patients
64.826	Medical Conditions of Cardiac and Pulmonary Patients
62.865	Electrocardiography
62.866	Laboratory in Exercise Testing and Prescription
64.810	Practicum in Physical Therapy (if required)
	or
	Elective

To help prepare for more diversified positions in the health-care setting, students should satisfy remaining credit requirements by selecting additional course work in one of the areas of research, education, administration, or clinical specialization.

Programs in Recreation and Leisure Studies

The Department of Recreation and Leisure Studies offers students the opportunity to select a master's degree program in one of two areas of professional specialization: Recreation Management or Therapeutic Recreation. In addition to completing the basic M.S. requirements, students enrolled in one of these programs are expected to complete twenty-four quarter hours of departmental course work,

including twelve quarter hours of departmental core classes and twelve quarter hours selected from the major area in which they are concentrating. Eight additional quarter hours of elective courses may be selected from other graduate offerings in the College or University.

Concentration in Recreation Management

The Recreation Management concentration is designed to assist students in acquiring advanced knowledge and developing skills that will enable them to assume a variety of leisure-service management positions. Upon graduation, students may pursue positions in commercial recreation and tourism, planning firms, health and fitness centers, federal agencies, and private agencies.

Concentration in Therapeutic Recreation

The Therapeutic Recreation concentration is designed to offer students opportunities to acquire advanced professional job skills that are essential for work with disabled people in positions in community-based settings and institutional settings, including hospitals, rehabilitation facilities, schools, and residential centers, as well as day-care, extended-care, shelter, and other transitional-care facilities.

Sample Program

Basic M.S. Requirements

Departmental Core Course Requirements

- 63.802 Contemporary Theories of Recreation and Leisure
- 63.812 Seminar in Contemporary Issues and Problems in Recreation Services
- 63.805 Program Evaluation in Recreation and Leisure Services

Specializations

Recreation Management Courses

- 63.814 Grantsmanship
- 63.816 Budgeting Systems
- 63.830 Advanced Organization and Administration of Recreation and Leisure Services
- 63.836 Public Relations for Recreation and Leisure Agencies

Therapeutic Recreation Courses

- 63.850 Therapeutic Recreation Services for Special Populations

63.852 Seminar on Programming in Therapeutic Recreation
63.853 Therapeutic Recreation: Interaction and Intervention Techniques
63.854 Observations of Therapeutic Recreation in Treatment Settings

Electives

Programs in Rehabilitation and Special Education

The Department of Rehabilitation and Special Education offers several graduate-level programs designed to offer practical training and competency preparation to individuals working with special-needs populations.

Integral to the various program curricula is a practicum or field experience, offering students the opportunity to acquire significant exposure to the practical application of theory and skills in a professional situation. While the actual nature of practicum requirements and the duration of such experiences vary from one program to another, students are assured of the opportunity to pursue their individual interests through practicum placements designed to integrate their work experiences with didactic portions of the program.

Program in Rehabilitation Administration

The master's degree program in Rehabilitation Administration is designed to help prepare students to meet both current and future personnel needs of expanding rehabilitation, health-care, and human-service programs in the United States and abroad. Academic course work is integrated with approximately 500 hours of practical experience in health and human-service programs, and courses of study are varied to enable each student to develop individual programmatic interests.

Sample Program

Basic M.Ed. Requirements

Departmental Course Requirements

56.950 Introduction to Rehabilitation
56.951 Principles of Medical Rehabilitation
56.952 Program Development in Rehabilitation
56.953 Organization and Administrative Theory
56.961 Fiscal Policy and Management I

56.963 Fiscal Policy and Management II
56.832 Group Dynamics
56.960 Practicum in Rehabilitation
56.956 Community Planning in Rehabilitation

Electives (chosen from prescribed course listing in consultation with adviser)

Programs in Rehabilitation Counseling

Both M.Ed. and CAGS programs are available in the area of Rehabilitation Counseling. The curricula for these programs are structured to help meet the needs of students interested in providing comprehensive services to the disabled and handicapped, offering the opportunity for specializations in Deafness, Mental Retardation, Mental Illness, Addiction/Alcoholism, Severe Special Needs, and Corrections. In addition to the required academic course work, students enrolled in the programs participate in a 600-hour practicum experience supplemented by seminar meetings that assist them in integrating theory with practice.

Sample M.Ed. Program

Basic M.Ed. Requirements

Departmental Course Requirements
56.950 Introduction to Rehabilitation
56.951 Principles of Medical Rehabilitation
56.965 Occupational Placement
56.980 Psychological Problems of Disability
56.960 Practicum in Rehabilitation Counseling

Specialized Courses
53.801 Tests and Test Procedures
53.804 Counseling Theory and Practice
53.815 Rehabilitation Counseling Strategies

Electives (chosen from recommended course listing in consultation with adviser)

Specialization in Deafness

A specialized component in deafness rehabilitation is available as part of the Rehabilitation Counseling program. Students who wish to specialize in this area may be required to take the following courses in addition to those requirements listed above:

55.823 Psychosocial Aspects of Communication Disorders
55.829 Foundations of Deaf Education

55.867	Intermediate Sign Language
55.868	Advanced Sign Language
19.890	American Sign Language I
19.891	American Sign Language II
19.892	ASL Intermediate I

Teacher Training Program: Moderate Special Needs

The Department of Rehabilitation and Special Education offers a master's-level teacher training program in Moderate Special Needs. A competency-based program approved by the Massachusetts State Department of Education, the program curriculum is designed to enable students who successfully complete program requirements to receive certification to teach children and adults having any of a wide range of moderate handicapping conditions—for example, mild mental retardation, learning disabilities, emotional disturbances, communication disorders, and certain physical impairments. Applicants to this program must hold or be eligible for regular teacher certification.

Sample Program

Basic M.Ed. Requirements

Departmental Course Requirements

55.806	Language Disturbances in Children
56.807	Educating Individuals with Learning Disabilities
56.831	Educating Individuals with Behavioral Disorders
56.840	Psychology of Individuals with Special Needs
56.846-7	Special Needs: Diagnostic-Prescriptive Teaching I and II
56.880-1	Etiology and Development of Special Needs
56.850	Fieldwork and Seminar
56.851	Student Teaching and Seminar

Teacher Training Program: Severe Special Needs

According to Massachusetts standard requirements for certification, teachers of severely handicapped children are expected to have competencies enabling them to work with and evaluate their students in several areas, including activities of daily living, sensory/motor performance, socialization, and language performance. The Severely Handicapped Teacher Training program offers a master's-level curriculum structured to help

students acquire these competencies through both course work and practicum experience. The program provides students the opportunity to acquire the necessary preparation to function as trained and skilled professional personnel who work closely with severely handicapped children. Students who successfully complete program requirements are eligible to receive Massachusetts certification in Severe Special Needs.

Sample Program

Basic M.Ed. Requirements

Departmental Course Requirements

56.880-1	Etiology and Development of Special Needs
55.806	Language Disturbances in Children
56.846-7	Special Needs: Diagnostic-Prescriptive Teaching I and II
56.839	The Severely Handicapped
56.838	Development and Implementation of Programs for the Severely Handicapped
56.835	Socio- and Psychodynamics of Family Life

Electives (chosen in consultation with adviser)

Programs in Speech-Language Pathology and Audiology

The programs leading to the degrees of Master of Education in Speech-Language Pathology and in Audiology are designed to help students prepare for certification by and membership in the American Speech-Language-Hearing Association (ASHA). It is assumed that students entering these programs have completed undergraduate degree programs in speech and hearing and are prepared to devote full-time study to their program. Part-time student status is discouraged and is available only to candidates who are currently employed in the field but who are not holders of the Certificate of Clinical Competence issued by ASHA. Full-time students are not allowed to change their status to part time once accepted for full-time study.

The degree programs in Speech-Language Pathology and in Audiology are fully accredited by ASHA-ETB (Educational Training Board) and are designed to distribute the student's course work to cover all major professional areas.

Sample Program in Speech-Language Pathology
Basic M.Ed. Requirements

Departmental Requirements

55.816	Test Procedures in Speech and Language Pathology
55.812	Differential Diagnosis in Speech and Language Pathology
55.804	Neurological Bases of Communication
55.805	Seminar: Voice Disorders
55.806	Language Disturbances in Children
55.811	Clinical Management of Stuttering
55.860	Aphasia Rehabilitation
55.865	Seminar: Speech Science
55.875,6,7	Advanced Clinical Practice I, II, III

Departmental Electives (minimum of one)

Sample Program in Audiology
Basic M.Ed. Requirements

Departmental Requirements

55.804	Neurological Bases of Communication
55.814	Clinical Audiometry I
55.815	Clinical Audiology
55.818	Pathologies of the Ear
55.819	Clinical Audiometry II
55.821	Seminar: Audiology
55.828	Aural Rehabilitation
55.862	Psychoacoustics
55.866	Hearing Science Seminar
55.875,6,7	Advanced Clinical Practice I, II, III

Departmental Electives (minimum of one)

Prerequisites for Physical Education Concentrations in Exercise Sciences and Movement Behavior

Students applying for concentration in Exercise Sciences or Movement Behavior must possess an undergraduate degree in physical education or present a minimum of eighteen semester hours (twenty-four quarter hours) of work in the following specified prerequisite courses:

Anatomy and Physiology	8 q.h.
Kinesiology	4 q.h.
Motor Learning and Development	4 q.h.
Exercise Physiology	4 q.h.
Measurement and Evaluation	4 q.h.

Doctor of Education Programs

General Information

Admission

Applicants for admission to the Doctor of Education degree program must file evidence of a master's degree and such other materials as are requested by the Graduate School for due consideration of the individual candidate's request for admission. Applicants are expected to have completed three years of successful professional administrative or leadership experience as attested to by their supervisors. Other experiences are evaluated by the appropriate department in individual cases.

Students already enrolled in a master's degree program in Boston-Bouvé Graduate School who expect to receive that degree within two terms of the time of application may submit materials for application consideration. Students who have graduated from or are enrolled as regular CAGS students in the Graduate School may also apply for the doctoral degree program. Although most CAGS course work is applicable, different admissions criteria apply, necessitating formal application. Conversely, regular doctoral students who choose not to complete the degree program or are disqualified from continuing may make formal application for transfer to the CAGS program.

Applicants to a doctoral program of study must declare a major field of specialization, submit a written statement of purpose in pursuing doctoral study, and, if requested, meet with an admissions committee for further evaluation. Specific admission requirements for the doctoral program are identical to those listed for the master's-level programs on page 8, with the exception that applicants for all doctoral programs must submit GRE scores.

Applications to the Doctor of Education degree programs are acted upon twice a year. Application materials must be completed by April 1 for individuals wishing to be considered for admission in the summer or fall quarters and by November 1 for those wishing to be considered for admission in the winter or spring quarters. Notification of admission status may be expected by May 15 and December 15, respectively.

Classification and Degree Candidacy
Students taking advanced graduate work are classified as follows:
1. Doctoral Student Students in this classification have been accepted for doctoral study, but have not yet passed the qualifying examination.
2. Doctoral Degree Candidate Students in this classification have completed forty-eight quarter hours of graduate work, including intermediate statistics, and have passed the qualifying examination.

Academic Requirements
To qualify for the Doctor of Education degree, students must maintain a B (3.000) average in their course work. No additional course credits are allowed to satisfy the B (3.000) average required for the degree. No student who receives a grade lower than B (3.000) in three or more courses is permitted to continue in the program. In addition, students who accumulate two grades of C from the same faculty member may not register for a third course with this faculty member. Students who receive a grade of F or U in a course must make up this course in accordance with their adviser's recommendation. Students who receive a grade of F or U in more than one course are not permitted to continue in the program.

Residency
In addition to course requirements, each student is expected to complete three quarters of full-time study in residence. Two of these quarters must be consecutive (one of which may be in the summer quarter); the third may occur at any time in the program or may be fulfilled through a full-time internship.

Qualifying Examination
Each doctoral student seeking degree candidacy must take a qualifying examination for the purpose of evaluating the student's general understanding of the field of specialization. The qualifying examination should be taken at a time when the student has completed forty to forty-eight quarter hours of doctoral study.

Comprehensive Examination
After completion of all formal course work, the doctoral degree candidate must satisfactorily demonstrate, by means of a comprehensive examination, breadth and depth of knowledge in the

area of specialization as well as general professional understanding and comprehension of major issues in related fields.

Dissertation

As part of the doctoral program, each candidate must complete a dissertation that embodies extended and creative independent research as well as proper evaluation and interpretation of its results. A Dissertation Committee, made up of a major adviser and at least two other faculty members, must approve the dissertation.

Final Oral Examination

Students take the final oral examination after completion of all other requirements for the doctoral degree. The substance of this examination includes the subject matter of the student's doctoral dissertation and significant developments in the area of his or her specialization.

The oral examination is scheduled at least eight weeks before the commencement at which the degree would be awarded, and results of the examination are immediately made available to the student.

Transfer Credit

The doctoral student's adviser may recommend that the Graduate Committee of Boston-Bouvé Graduate School award transfer credit for up to 25 percent of the course work required of the student to complete the doctoral degree. Credit offered for transfer must consist of work taken at the graduate level for credit beyond a master's degree, have been earned at an accredited institution, and carry grades of A or B.

Students desiring transfer credit should petition the Graduate School, in writing, by completing the necessary form obtainable from the Graduate School office or their faculty adviser. The completed form must be submitted to the Director of the Graduate School together with an official transcript and an excerpt from the catalog describing the course(s) for which transfer credit is requested. No transfer-credit request form will be considered complete without the signature of the student's adviser or department chairperson. Grades on transfer credits may not be used for the purpose of obtaining the academic average necessary for the completion of degree requirements.

Students are informed in writing when transfer credit is officially awarded.

Time Limitation

Students must complete degree requirements within a maximum of five years after admission to degree candidacy. Any extension of this time must be approved by the Committee of the Boston-Bouvé Graduate School.

Course credits earned in the program of graduate study or accepted by transfer are valid for a maximum of seven years from the time taken to completion of degree requirements.

Course Descriptions

Course descriptions are available in the academic departments and in the Graduate School office.

Program Descriptions

The Graduate School of Boston-Bouvé College of Human Development Professions offers several Doctor of Education programs in the area of Leadership: Administration and Supervision. Specific concentrations are available in Pupil and Student Personnel Administration, Cooperative Education Administration, Higher Education and School Administration, and Special Education and Rehabilitation Administration.

Doctoral programs in the Graduate School are offered jointly by the various departments and bring together relevant aspects of each.

Although each student's program is individually developed, some general requirements apply to all. In addition to those requirements outlined on pages 33-35, doctoral students must complete the required core courses listed under the sample program. In each student's program, the major field of study must be complemented by two minor areas of study.

Sample Program

Required Core Courses

52.850 Doctoral Seminar in Leadership: Administration and Supervision I

52.851 Doctoral Seminar in Leadership: Administration and Supervision II

52.852 Doctoral Seminar in Leadership: Administration and Supervision III

Specialization Courses

A planned sequence of courses (minimum of thirty-two quarter hours) in the student's specific area of concentration

Supporting Minor Area Courses

A planned sequence of graduate courses (minimum of twelve quarter hours) from offerings available in programs outside Boston-Bouvé College of Human Development Professions; in addition to a planned sequence of graduate courses (minimum of twelve quarter hours) from offerings available within Boston-Bouvé Graduate School.

Dissertation and Appropriate Seminar

Financial Information

Tuition

Tuition for master's degree candidates, CAGS candidates, doctoral candidates, and special students is $85 per quarter hour of credit. Tuition for audited courses is the same as for courses taken for credit. There is a special tuition charge of $815 for the following: 51.805 Student Teaching, 51.873 and 51.875 Reading Clinic I and II, 51.893-894 Seminar in Supervision of Instruction and Practicum, 53.805-806 Counseling Practicum, 53.840-841 Advanced Fieldwork, 53.843-844 School Psychology Fieldwork, 55.875-877 Advanced Clinical Practice, 55.852 Student Teaching of the Hearing Impaired, 56.850-851 Fieldwork and Student Teaching, 56.853-854 Fieldwork and Practicum, 56.960 Practicum in Rehabilitation, 93.802-803 Practicum in Early Childhood Education I and II, and Thesis.

A special tuition fee of $407.50 is charged for 52.843 Administrative Internship and 56.970 CAGS Rehabilitation Practicum as well as for Counselor Education interns enrolled in the Boston School System.

The tuition charge for the doctoral dissertation is $600, to be paid when registering for the dissertation. At the completion of formal course work for the doctorate, a dissertation continuation fee of $50 per quarter is charged until completion of the dissertation.

A $100 nonrefundable tuition deposit, payable upon acceptance into the programs, is required of all full-time students accepted by the Departments of Counselor Education and Speech-Language Pathology and Audiology. This deposit is applied to the tuition for the first quarter of study.

Tuition statements are mailed to students by the Bursar's Office and are payable by check to Northeastern University on or before the date specified. Tuition rates and fees are subject to revision by the Board of Trustees at any time.

Fees and Refunds

An application fee of $25 (nonrefundable) is charged to all students applying for admission to Boston-Bouvé Graduate School. No application papers are processed until this fee is

received. Checks should be made payable to Northeastern University and submitted with application materials to Boston-Bouvé Graduate School, 102 Fenway, Boston, Massachusetts 02115.

Other fees include a charge of $25 to $50 for late payment of tuition, a fee of $5 for deferred tuition (with approval of the Bursar), and a graduation fee of $25 for all degree candidates, payable by the applicable date listed on the academic calendar, usually four weeks before commencement.

In addition, there is a one-time fee of $100 charged to new graduate international students, payable upon acceptance at Northeastern.

Full-time students are charged $12.50 per quarter for the services available in the Student Center. The same fee for teaching assistants and research fellows is $6.25 each quarter. Part-time students on the Huntington Avenue campus are charged $.75 per quarter.

All full-time students, including those with assistantships and fellowships, also pay a nonrefundable University Health Services fee of $200 per year for Blue Cross-Blue Shield coverage. Payment of this fee entitles the student to medical care provided by the University Health Service.

All financial obligations to the University must be cleared before graduation.

Assistantships

The Graduate School awards a limited number of assistantships to qualified students each year. Some awards offer remission of tuition; other awards carry a tuition scholarship and also offer students the opportunity to earn a small stipend. The assigned duties and hours of work students assume with the award vary, depending on the specific award.

Students interested in applying for assistantships should contact Boston-Bouvé Graduate School, 102 The Fenway, Boston, Massachusetts 02115. Students applying must also file a (GAPSFAS) and a Graduate School Information and Application form with the Office of Financial Aid.

Financial Aid

The Office of Financial Aid offers several types of limited assistance to eligible graduate students. All awards are based on financial need. Since the majority of these awards are sponsored by the federal government, the amount of aid granted is

determined by the amount of funds allocated to Northeastern University each year.

In order to meet the financial aid application deadlines, students may have to apply for financial aid before they have been offered admission to the Graduate School. However, only those students who have been accepted are reviewed for financial aid.

Although students who are not United States citizens are eligible for fellowships, assistantships, and tuition scholarships, the University awards financial aid only to eligible students who are U.S. citizens and permanent residents of the United States. Students who are studying in the United States on student visas are not eligible for federal assistance.

Students interested in information concerning the National Direct Student Loan, the College Work-Study Program, and the Guaranteed Student Loan Program should write the Financial Aid Office, 254 Richards Hall, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115.

General Regulations

Policy Statement

The general regulations and minimum requirements for all graduate programs are established by the Northeastern Graduate Council. In some matters, the committee of each graduate school is allowed discretion to establish regulations within limits defined by the Council. The regulations and academic requirements that follow have been formulated in accordance with this general policy. Students who wish to have consideration for variations in existing policy may petition the Committee of Boston-Bouvé Graduate School.

Residence

All work for advanced degrees must be completed at the University unless approval for work taken elsewhere has been obtained from the Director of the Graduate School. Students who are in residence and are using the facilities of the University must register for such work.

Grading System

Students' performance in graduate courses is graded according to the following numerical equivalents:

A (4.000) This grade is given to those students whose performance in the course is of very high graduate caliber.

A– (3.667)

B+ (3.333)

B (3.000) This grade is given to those students whose performance in the course is at a satisfactory level.

B– (2.667)

C+ (2.333)

C (2.000) This grade is given to those students whose performance in the course is not at the level expected in graduate work.

C– (1.667)

F (0) This grade is given to those students whose performance in the course is unacceptable.

In addition, the following letter designations are used:

I Incomplete
This grade is given to those students who fail to complete the work of the course.

L Audit without credit

S Satisfactory without quality designation

U Unsatisfactory without quality designation

Grades S and U may be used for the first quarter of a two-quarter sequence in which the grade for the second quarter applies to both the first and second quarters of the sequence.

The I grade is changed to a letter grade upon removal of the deficiency that caused the grade of I to be reported. Deficiencies must be made up within the quarter following that for which the grade of I is received unless an extension of time is granted by the instructor. Any I grade outstanding for twelve months or more remains permanently and irreversibly as an I grade on the student's record.

The University does not process grades for students who are not officially registered by the end of the fifth calendar week of a quarter.

Changes in Requirements

The continuing development of the Graduate School may occasion frequent revision of curricula. In every new bulletin some improvements are announced. When no hardship is imposed on the student because of such changes, and when the facilities of the school permit, the student is expected to meet the requirements of the latest bulletin. If the student finds it impossible to meet these requirements, the bulletin for the year in which he or she entered becomes the binding one.

Application for Degree

Students must officially apply for a degree by completing a commencement card. If the commencement card is not filed with the Registrar's Office on or before the applicable date listed on the calendar, there is no assurance that the degree will be granted in that particular year even though all other requirements have been fulfilled.

Academic Classification

1. Regular Applicants who meet in full the criteria for immediate matriculation are classified as regular students.

2. Provisional Some applicants who do not meet regular admissions standards may be admitted as provisional students. Such students must maintain a B (3.000) average in their first twelve quarter hours of work in order to continue in the graduate program. Provisional students admitted for part-time study may take only one course in their first quarter of study.

3. Special Applicants who have earned a bachelor's degree from an accredited institution and who acknowledge that they do not wish to pursue a degree may be accepted as special students.

Auditing

A student may audit a course without credit by obtaining, prior to registration, the written approval of the instructor of the course and by presenting this permit at the office of the Boston-Bouvé Graduate School. No change either to or from the audit status may be made after the first day of classes. Tuition for an audit course is the same as for a course taken for credit.

Class Hours and Credits

All credits are entered as quarter hours. A quarter hour of credit is equivalent to three-fourths of a semester-hour credit. The academic calendar at the back of this bulletin should be consulted to determine the opening and closing dates of each quarter. It should be noted that most classes meet either in the late afternoon or evening.

Continuity of Program

Students are expected to maintain continuous progress toward a degree. Any student who has been admitted to a degree program and completed at least one course, but not attended for a period of one year, must submit to the office of Boston-Bouvé Graduate School a written request for reinstatement in the program. After receiving formal notification of reinstatement, students must meet with their program advisers to make any necessary program adjustments.

Withdrawals

To withdraw from a course, students must fill out an official withdrawal form obtained at the Registrar's office or at the Burlington Campus office. Withdrawals may be made through

the ninth week of the quarter. Students are withdrawn as of the date on which the form is returned to the Office of the Registrar, Room 120 Hayden Hall. Ceasing to attend a class or simply notifying the instructor of intention to withdraw does not constitute an official withdrawal.

Academic withdrawals from Boston-Bouvé Graduate School are made by the Director when students fail to meet the academic requirements.

A grade of W is given to students who withdraw after the fifth calendar week of a quarter.

The University

Founded in 1889, Northeastern University is incorporated as a privately endowed nonsectarian institution of higher learning under the General Laws of Massachusetts. The state legislature by special enactment has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of nearly 180 distinguished business and professional men and women.

From its beginning, Northeastern University has held the primary goals of discovering community educational needs and meeting these needs in distinctive and serviceable ways. The University has not attempted to duplicate the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan of Education initiated by the College of Engineering in 1909 and subsequently adopted by the other colleges of the University. This educational method offers students the opportunity to gain valuable practical experience as an integral part of their college program and often provides the means by which they may contribute substantially to the financing of their education. The Plan has been extended to the graduate level in engineering, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. University College offers evening courses—available at the University since 1906—and adult day courses leading to the bachelor's degree. In addition to offering day undergraduate programs in Electrical Engineering Technology and Mechanical Engineering Technology, Lincoln College offers evening/part-time certificate, associate, and bachelor degree programs in technological areas.

Graduate and Professional Schools

The eight graduate and professional schools of the University offer numerous programs of study leading to the following degrees:

The Graduate School of Arts and Sciences offers the degrees of Master of Arts, Master of Science, Master of Science in Health Science, Master of Public Administration, and Doctor of Philosophy, as well as a Certificate of Advanced Graduate Study in Advanced Literary Study.

The Graduate School of Boston-Bouvé College of Human Development Professions offers the degrees of Master of Education, Master of Science, and Doctor of Education in addition to the Certificate of Advanced Graduate Study.

The Graduate School of Business Administration offers the degree of Master of Business Administration.

The Graduate School of Criminal Justice offers the degree of Master of Science.

The Graduate School of Engineering offers the degrees of Master of Science, Engineer degree, Doctor of Engineering, and Doctor of Philosophy.

The School of Law offers the degree of Juris Doctor.

The Graduate School of Pharmacy and Allied Health Professions offers the degrees of Master of Science, Doctor of Philosophy, and Doctor of Pharmacy.

The Graduate School of Professional Accounting offers the degree of Master of Science in Accounting.

Department Directory

	Room	Phone
Associate Dean and Director of Graduate School	119 CU	437-3297
Assistant Dean of Graduate School	118 CU	437-2708
Coordinator of Graduate Admissions	118 CU	437-2708
Department of Counselor Education	405 CU	437-3276
Department of Curriculum and Instruction	1 LA	437-3302
Department of Educational Administration	225 CU	437-3286
Department of Foundations of Education	306 CU	437-3282
Department of Health Education	304 DK	437-3145
Department of Physical Education	105 DK	437-3153
Department of Physical Therapy	308 RB	437-3160
Department of Recreation and Leisure Studies	3 DK	437-3163
Department of Rehabilitation and Special Education	202 LA	437-2485
Department of Speech-Language Pathology and Audiology	106 FR	437-2493

Campus Map

NORTHEASTERN UNIVERSITY
BOSTON, MASSACHUSETTS
SCALE
STREET DIRECTION
PARKING
FENWAY
HEMENWAY ST
GAINSBOROUGH ST
FORSYTH WAY
HUNTINGTON AVENUE
(ROUTE 9)
ST. STEPHEN ST
ST. BOTOLPH ST
SPEARE PLACE
OPERA PL
PARKER ST
LEON ST
FORSYTH ST
RUGGLES ST
COLUMBUS AVENUE
SOUTH PARKING AREA
MBTA
Back Bay/Fens
Museum of Fine Arts
Parker House
Boston YMCA
New England Conservatory of Music
NU Arena
YMCA PARKING
KEY
UNDERGROUND TUNNELS
PARKING AREAS
ROUTE FOR HANDICAPPED
PARKING FOR HANDICAPPED

Academic Calendar

Fall Quarter 1981		
Registration period		
Burlington	Sept. 15-16	1:00-3:00 p.m., 5:30-8:00 p.m.
Boston	Sept. 21-24	1:00-8:00 p.m.
Classes begin	Sept. 28	
Examination period	Dec. 14-19	
Winter Quarter 1981-82		
Registration period		
Burlington	Dec. 1	1:00-3:00 p.m., 5:30-8:00 p.m.
Boston	Dec. 7-10	1:00-3:00 p.m., 5:30-8:00 p.m.
Classes begin	Jan. 4	
Examination period	March 22-27	
Spring Quarter 1982		
Registration period		
Burlington	March 9	1:00-3:00 p.m., 5:30-8:00 p.m.
Boston	March 15-18	1:00-3:00 p.m., 5:30-8:00 p.m.
Classes begin	April 5	
Examination period	June 14-19	
Summer Quarter 1982		
Registration period		
Burlington	June 14-15	5:30-8:00 p.m.
Boston	June 16-17	5:30-8:00 p.m.
Classes begin	June 28	
Examination period	Aug. 4-5	

University Holidays 1981-82

Columbus Day	Monday	October 12
Veterans Day	Wednesday	November 11
Thanksgiving Recess	Thursday-Saturday	November 26-28
Christmas Vacation	Monday-Saturday	Dec. 21-Jan. 2
Martin Luther King Day	Friday	January 15
Washington's Birthday	Monday	February 15
Patriot's Day	Monday	April 19
Memorial Day	Monday	May 24
Independence Day	Monday	July 5
Labor Day	Monday	September 6

Calendar changes may be made. The University community will be notified if such changes are necessary.

Emergency Closing of the University

Northeastern University has made arrangements to notify students, faculty, and staff by radio when it becomes necessary to cancel classes because of extremely inclement weather. Radio stations WBZ, WEEI, WHDH, WJDA, WRKO, WKOX, WHAV, WCOZ-FM, WNSR, WLYN-FM, WVBF-FM, WHUE, and WLLH will announce the University's decision to close.

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity for all. In all matters involving admissions, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination. Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age, national origin, or on the basis of being a handicapped but otherwise qualified individual. In addition, Northeastern takes affirmative action in the recruitment of students and employees. Inquiries concerning our equal opportunity policies may be referred to the University Affirmative Action Officer, 175 Richards Hall, 617-437-2133 or 2139. Northeastern's efforts to comply with the Title IX Educational Amendments of 1972 are also coordinated by the Dean and Director of Affirmative Action, 175 Richards Hall, 617-437-2133.

Family Educational Rights and Privacy Act

In accordance with the Family Educational Rights and Privacy Act of 1974, Northeastern University permits its students to inspect their records wherever appropriate and to challenge specific parts of them when they feel it necessary to do so. Specific details of the law as it applies to Northeastern are printed in the *Student Handbook* and are distributed annually at registrations of University College and the graduate schools.

Delivery of Services

The University assumes no liability, and hereby expressly negates the same, for failure to provide or delay in providing educational or related services or facilities or for any other failure or delay in performance arising out of or due to causes beyond the reasonable control of the University, which causes include, without limitation, power failure, fire, strikes by University employees or others, damage by the elements and acts of public authorities. The University will, however, exert reasonable efforts, when in its judgment it is appropriate to do so, to provide comparable or substantially equivalent services, facilities or performance, but its inability or failure to do so shall not subject it to liability.

The Northeatern University catalog contains *current information* regarding the University calendar, admissions, degree

requirements, fees and regulations, and such information is not intended to be and should not be relied upon as a statement of the University's contractual undertakings.

Northeastern University reserves the right in its sole judgment to promulgate and change rules and regulations and to make changes of any nature in its program, calendar, admissions policies, procedures and standards, degree requirements, fees, and academic schedule whenever it is deemed necessary or desirable, including, without limitation, changes in course content, the rescheduling of classes, cancelling of scheduled classes and other academic activities and requiring or affording alternatives for scheduled classes or other academic activities, in any such case giving such notice as is reasonably practicable under the circumstances.

We at Northeastern will do our best to make available to you the finest education we can provide, the most stimulating atmosphere in which to learn, and the most congenial conditions under which you may enjoy the learning experience. But the quality and the rate of progress of your academic career is in large measure dependent upon your own abilities, commitment, and effort. You will be a full participant in an educational partnership. We will and, indeed, can only make the opportunities available to you; it is up to you to take advantage of them.

This is equally true with your career upon graduation. We cannot guarantee that you will obtain any particular job; that will depend upon your own skills, achievement, presentation, and other factors such as market conditions at that time. Similarly, in many professions and occupations there are increasing requirements imposed by federal and state statutes and regulatory agencies for certification or entry into a particular field. These may change during the period of time when you are at Northeastern and they may vary from state to state. While we will be ready to help you find out about these requirements and changes, it is your responsibility to initiate the inquiry because we cannot know what your expectations and understanding are unless you tell us.

In brief, what we are saying to you is that we are here to offer you educational opportunities and choices and to assist you in finding the direction in which you want to steer your educational experience. But you are a partner in this venture with an obligation and responsibility to yourself.

The Governing Boards and Officers of the University

July 31, 1981

The Corporation

Julius Abrams
William T. Alexander
William F. Allen, Jr.
**Diana J. Auger

*Vincent Barletta
Allen G. Barry
Lincoln C. Bateson
*Roy H. Beaton
†F. Gregg Bemis
Beverly Ann Bendekgey
Robert P. Berkowitz
Alfred M. Bertocchi
Gerald W. Blakeley, Jr.
S. Whitney Bradley
Melvin B. Bradshaw
Rexford A. Bristol
Edward W. Brooke
*Frederick L. Brown
†George R. Brown
William L. Brown
William H. Bruce, Jr.
John L. Burns
Hyman H. Burstein
Victor C. Bynoe

*Louis W. Cabot
*Norman L. Cahners
Henry F. Callahan
*Thomas E. Cargill, Jr.
*Richard P. Chapman
Richard P. Chapman, Jr
Theodore Chase
Robert F. Chick
Vessarios G. Chigas
Carl W. Christiansen
Logan Clarke, Jr.
Livingstone N. Coakley
*David H. Cogan
Abram T. Collier
T. Paul Connolly
Edward Creiger

H. James Crossan, Jr.

Roger C. Damon
Nelson J. Darling, Jr.
Melanie Dean
(Melanie C. Berger)
Virginia Schenkelberger
Devine
William O. DiPietro
Alfred di Scipio
Estelle Dockser
Dorothy Dodge
**William R. Driver, Jr.

William S. Edgerly
William Elfers
*Byron K. Elliott
*William P. Ellison
Robert Erickson

*Frank L. Farwell
Joseph D. Feaster, Jr.
*James V. Fetchero
*Eldred L. Field
Phil David Fine
Joseph F. Ford
Albert S. Frager
Brenda J. Furlong

Thomas J. Galligan, Jr.
Murray J. Gart
Paul W. Glennon
*Lloyd S. Glidden, Jr.
John L. Grandin
**Donald B. Guy

*Allan M. Hale
Edmund Blair Hawley
Michael E. Haynes
James S. Hekimian
William Hellman
*Ernest Henderson III
Joseph E. Heney
James S. Herbert

Arnold S. Hiatt
Richard D. Hill
Thomas Hollis, Jr.
D. Brainerd Holmes
Robert W. Holmes
Hartwell G. Howe
John S. Howe
Howard M. Hubbard
*Carl R. Hurtig

Richard P. Johnson
*Robert L. Johnson
*Henry C. Jones

*George S. Kariotis
†Frances Kenerson
Edward M. Kennedy
Fenton G. Keyes
Calvin A. King
*Asa S. Knowles
Harvey C. Krentzman

Evelyn M. Lane
John P. LaWare
*Joseph C. Lawler
Maurice Lazarus
Elma I. Lewis
*Kenneth A. Loftman
Edward A. Loring
*John Lowell
*Diane H. Lupean

*Roderick M. MacDougall
Evelyn Marran
**Lawrence H. Martin
M. Dorothy Massey
*George J. Matthews
Walter E. Mattson
*J. Edwin Matz
Peter H. McCormick
William J. McCune, Jr.
Katherine Seay McHugh

*Member of the Board of Trustees
**Honorary Trustee
†Lifetime Trustee, Emeritus

Percy M. McIntosh
Dominic Meo, Jr.
William C. Mercer
Don G. Mitchell
Donald H. Moore
Frank E. Morris
James A. Morris
William B. Moses, Jr.
**Stephen P. Mugar

William H. Nichols, Jr.
Kathryn A. Nicholson

Bernard J. O'Keefe
Stanley C. Olsen
James H. Orr
Ara Oztemel

*Augustin H. Parker
Edward S. Parsons
*Amelia Peabody
Theodore R. Peary
Lawrence T. Perera
Nicholas V. Petrou
Edward E. Phillips
*Thomas L. Phillips
Edward D. Phinney
Rudolph F. Pierce
Jerome M. Powell
Albert Pratt
Peter W. Princi
*William J. Pruyn
George Putnam

Blanche M. Quaid
*Francis J. Quirico

William H. Raye, Jr.
Kathleen M. Rice
R. Earl Roberson
Daniel J. Roberts
†Dwight P. Robinson, Jr.
Ralph B. Rogers
Ronald L. Rossetti
*Kenneth G. Ryder

Ernest J. Sargeant
David T. Scott
Donald W. Seager
Sydney Shaftman
James L. Shanahan
Robert E. Siegfried
*Dorothy M. Simon
Philip A. Singleton
Paul D. Slater
*Charlotte B. Smith
*Donald W. Smith
*Farnham W. Smith
*George A. Snell
O. Phillip Snowden
*Bernard Solomon
Robert C. Sprague
Milton Stern
David B. Stone
Ruth B. Stuart

Lawrence I. Templeman
Charles H. Tenney II
Almore I. Thompson
Milton A. Thompson
W. Nicholas Thorndike
Alan D. Tobin
*D. Thomas Trigg
Paul E. Tsongas
†Chaplin Tyler

Samuel Wakeman
Martin F. Walsh
*An Wang
Lloyd B. Waring
James L. Waters
David T. Wendell
William C. White
*Robert H. Willis

Richard W. Young

**Alvin C. Zises

Northeastern University Publishing Group
July 1981

Officers of the Corporation and Board of Trustees

Robert H. Willis, Chairman
Norman L. Cahners, Vice Chairman
Frank L. Farwell, Vice Chairman
Farnham W. Smith, Vice Chairman
D. Thomas Trigg, Vice Chairman-Finance
Philip C. Boyd, Secretary
Byron K. Elliott, Honorary Chairman
William R. Driver, Jr., Honorary Vice Chairman
Dwight P. Robinson, Jr., Honorary Vice Chairman

Board of Trustees

Class of 1981
Norman L. Cahners
Richard P. Chapman
William P. Ellison
James V. Fetchero
Ernest Henderson III
Carl R. Hurtig
Asa S. Knowles
Joseph C. Lawler
George J. Matthews
Donald W. Smith

Class of 1982
Frederick L. Brown
David H. Cogan
Frank L. Farwell
Lloyd S. Glidden, Jr.
Allan M. Hale
Henry C. Jones
J. Edwin Matz
Farnham W. Smith
George A. Snell
D. Thomas Trigg

Class of 1983
Vincent Barletta
Roy H. Beaton
Louis W. Cabot
Byron K. Elliott
Kenneth A. Loftman
John Lowell
Roderick M. MacDougall
Augustin H. Parker
Francis J. Quirico
Charlotte B. Smith
An Wang

Class of 1984
Thomas E. Cargill, Jr.
Eldred L. Field
Robert L. Johnson
George S. Kariotis
Diane H. Lupean
Amelia Peabody
Thomas L. Phillips
William J. Pruyn
Dorothy M. Simon
Bernard Solomon
Robert H. Willis

Ex Officio
††Kenneth G. Ryder

Honorary Trustees
Diana J. Auger
William R. Driver, Jr.
Donald B. Guy
Lawrence H. Martin
Stephen P. Mugar
Alvin C. Zises

Lifetime Trustees, Emeriti
F. Gregg Bemis
George R. Brown
Frances Kenerson
Dwight P. Robinson, Jr.
Chaplin Tyler

††President of the University

Administrative Organization

Officers of the University

Arthur W. Brodeur, B.S., *Vice President for Public Affairs*

John A. Curry, A.B., Ed.M., Ed.D., *Senior Vice President for Administration*

Edmund L. Deltano, B.A., *Vice President for Finance*

Asa S. Knowles, A.B., A.M., LL.D., Litt.D., Sc.D., D.B.A., Sc.D. in Bus. Ed., *Chancellor*

Melvin Mark, B.S., M.S., Sc.D., *Senior Vice President for Academic Affairs and Provost*

John A. Martin, B.S., M.B.A., *Vice President for Business*

John D. O'Bryant, B.S., M.Ed., *Vice President for Student Affairs*

Eugene M. Reppucci, Jr., B.S., M.Ed., *Vice President for University Development*

Daniel J. Roberts, B.S., M.B.A., Ed.M., *Senior Vice President-Treasurer*

Kenneth G. Ryder, A.B., M.A., L.H.D., *President*

Royal K. Toebes, B.S., M.B.A., *Vice President for Alumni Development*

Roy L. Wooldridge, B.S., Ed.M., *Vice President for Cooperative Education*

Academic Deans, Directors of Schools, and General Administrative Officers

Richard Astro, B.A., M.A., Ph.D., *Dean of the College of Arts and Sciences*

Joseph E. Barbeau, B.S., M.Ed., Ed.D., *Associate Dean and Director of Graduate Studies, Boston-Bouvé College of Human Development Professions*

David H. Blake, A.B., M.B.A., Ph.D., *Dean of the College of Business Administration*

Philip T. Crotty, A.B., A.M., M.B.A., Ed.D., *Vice Provost*

Charles Devlin, B.S., M.Ed., *Dean of Student Financial Services*

Theodore N. Ferdinand, B.S., M.S., Ph.D., *Director of the Graduate Program in Criminal Justice*

Clifford J. Fralen, B.S., M.S.E., M.B.A., *Director of the Physical Plant*

William A. Frohlich, B.A., *Director of University Publishing Group and Director of University Press*

Job E. Fuchs, M.D., *Director of Health Services*

Joseph M. Golemme, S.B., M.A., C.P.A., D.C.S., *Director of the Graduate School of Professional Accounting*

Ellen S. Jackson, B.A., Ed.M., C.A.G.S., *Dean and Director of Affirmative Action*

John W. Jordan, B.S., M.Ed., *Dean of University College*

Christopher F. Kennedy, A.B., Ed.M., *Dean of Administration*

Thomas J. Kerr, B.S., M.S., Ph.D., *Director of the Graduate School of Engineering and Acting Assistant Dean of Engineering*

William F. King, B.S., M.S., *Director of Lincoln College and Associate Dean of Engineering*

Philip LaTorre, B.S., M.S., *Dean of Personnel Services and Director of Environmental Health*

Paul M. Lepley, B.S., M.Ed., Ed.D., *Dean of Boston-Bouvé College of Human Development Professions*

Juanita O. Long, B.S.N., M.S.N., C.A.G.S., *Dean of the College of Nursing*

Harold Lurie, B.S., M.S., Ph.D., *Dean of the College of Engineering*

Philip McCabe, B.A., M.Ed., *Dean of Admissions*

Michael C. Meltsner, A.B., LL.B., *Dean of the School of Law*

Roland H. Moody, A.B., B.L.S., *Director of the University Libraries*

Thomas E. Moore, B.A., M.Ed., M.B.A., *Director of the Graduate School of Business Administration and Associate Dean of the College of Business Administration*

Edmund J. Mullen, B.A., M.Ed., *University Registrar*

Robert Najjar, B.A., M.B.A., *Bursar*

J. Edward Neighbor, B.S., M.S., Ph.D., *Director of the Graduate School/Sciences and Associate Dean of the College of Arts and Sciences*

John L. Neumeyer, B.S., Ph.D., *Director of the Graduate School of Pharmacy and Allied Health Professions*

Paul M. Pratt, B.S., M.Ed., *Dean of the Department of Cooperative Education*

Susan E. Rindler, B.A., M.A., Ph.D., *Director of the Graduate School/Humanities and Social Sciences and Associate Dean of the College of Arts and Sciences*

Edward W. Robinson, B.S., Ed.M., *Dean of Students*

Norman Rosenblatt, A.B., Ph.D., *Dean of the College of Criminal Justice*

Jeanne L. Rowlands, B.A., B.S., M.A., *Director of Women's Athletics*

Gerald E. Schumacher, Pharm.D., M.Sc., Ph.D., *Dean of the College of Pharmacy and Allied Health Professions*

Karl Weiss, B.S., Ph.D., *Vice Provost*

Virgil A. Wood, A.B., B.D., C.A.S., Ed.D., *Dean and Director of the African-American Institute*

Joseph Zabilski, B.S., *Director of Men's Athletics*

General University Committees

The Academic Council**

Kenneth G. Ryder, Chairman
Melvin Mark, Vice Chairman
M. Patricia Hinds, Secretary

Richard Astro
David H. Blake
Philip T. Crotty
John W. Jordan
William F. King
Paul M. Lepley
Juanita O. Long
Harold Lurie
Kathryn Luttgens
Michael C. Meltsner
Paul M. Pratt
Norman Rosenblatt
Gerald E. Schumacher
Arthur D. Smith
Karl Weiss
Ex Officio
Arthur W. Brodeur
John A. Curry
Charles H. Ellis
Daniel J. Roberts
Roy L. Wooldridge

The Administrative Council**

Kenneth G. Ryder, Chairman
John A. Curry, Vice Chairman
Barbara F. Burke, Secretary

Arthur W. Brodeur
Charles W. Coffin
Philip T. Crotty
Edmund L. Deltano
Charles H. Ellis
Clifford J. Fralen
Humberto F. Goncalves
Ellen S. Jackson
Christopher F. Kennedy
Philip La Torre
Melvin Mark
John A. Martin
Philip R. McCabe
Christopher Mosher
John D. O'Bryant
Eugene M. Reppucci, Jr.
Daniel J. Roberts
Royal K. Toebes
Karl Weiss
Roy L. Wooldridge

The Faculty Senate

*Melvin Mark, Presiding Officer

Richard L. Arnowitt
*Richard Astro
Samuel J. Bernstein
Betsey W. Blackmer
*David H. Blake
Franklyn K. Brown
Richard L. Canale
Holly M. Carter
*John A. Curry
Arthur Davis, Jr.
John Diffenbach
Charles H. Ellis
Steven E. Erikson
M. Rita Flynn
Norbert L. Fullington
Michael J. Glaubman
Harold M. Goldstein
Minton F. Goldman
Robert A. Gonsalves
Peter J. Graham, Jr.
Jessie L. Hansen
Conrad M. Jankowski
Debra R. Kaufman
Maurice Kaufman
John Klaas II
Frank F. Lee
*Paul M. Lepley
*Juanita O. Long
*Harold Lurie
Helen S. Mahut
Roger N. Millen
*Paul M. Pratt
*Norman Rosenblatt
*Gerald E. Schumacher
Wallace W. Sherwood
Marilyn M. Smith
Richard R. Stewart
Michael T. Vaughn
John Zotos

*Appointed by the President

**An additional member to be chosen in the fall by the Faculty Senate Agenda Committee.

Lincoln College
Northeastern University
1982–84

Day and evening programs in:

aviation technology
engineering technology
science technology

Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

SPORTS EVENTS
HOME FOOTBALL SCHEDULE
3 SPRINGFIELD 1 PM
24 NEW HAMPSHIRE 1 PM
31 MAINE 1 PM
14 LEHIGH
21 BU

contents

Page

4 Application Form for Further Information
6 Campus Map
7 Calendar 1982-1984
17 The University
27 Buildings and Facilities
31 Lincoln College Administration
35 The Role and Scope of Lincoln College
36 Programs of Instruction
41 Admissions Information
44 Registration
45 Academic Information
55 Financial Information
61 Student Activities and Alumni Information
65 Academic Programs of Instruction
66 Pre-Technology Preparation
67 Aeronautical Technology
70 Civil Engineering Technology
77 Electrical Engineering Technology
82 Mechanical-Structural Engineering Technology
88 Interdisciplinary Engineering and Science Programs
89 Computer Technology
92 Mechanical-Structural Technology
95 Description of Courses
96 Index to Courses
137 The Lincoln College Faculty
148 Northeastern University Corporation
150 The Board of Trustees
151 Administrative Organization
153 General University Committees

Northeastern University
Lincoln College
360 Huntington Avenue Boston, Massachusetts 02115
Telephone 437-2500

_____ 19_____

Please send me an application for admission for:

□ Lincoln College Evening Programs

□ Day BET programs

□ Will you please arrange for me to have an interview to discuss your program in _____

□ I would like to apply for advance standing credit and shall arrange to submit transcripts of my records at all schools attended since high school.

_____
Signature

_____
Street Address City State Zip Code

Office Hours at Huntington Avenue Campus, Boston

September to June

Monday-Thursday ..... 8:30 a.m.-8:00 p.m.
Friday ..... 8:30 a.m.-4:30 p.m.
(Summer schedule subject to change)

Suburban Campus, Burlington

The bookstore is open from 8:00 a.m.-7:00 p.m. Monday through Thursday; 8:00 a.m.-4:00 p.m. on Friday; the Bursar's Office is open from 8:30 a.m.-8:00 p.m. Monday through Thursday; 8:30 a.m.-4:30 p.m. on Friday.

Program Counseling

Program counselors are available on a regular schedule at both the Boston Campus and the Burlington Campus. Appointments may be arranged by telephoning the Lincoln College office at 437-2500.

Interviews

Prospective students, or those desiring advice or guidance regarding any part of the school work or curricula, are encouraged to arrange for personal interviews. Career planning through competent guidance provides an understanding of professional requirements and develops that definiteness of purpose so vital to success. The Lincoln College office is located at 408 Churchill Hall on the Boston Campus.

Address communications to:

Director
Lincoln College
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115
Telephone 437-2500

Aeronautical Technology
Suburban Campus
South Bedford Road
Burlington, Massachusetts 01803
Telephone 272-5500
Extension 35

Academic and Service Buildings

Afro-American Institute	I3
Barletta Natatorium	G6
Boston YMCA	F10
Botolph Building	G10
Cabot Physical Education Building	G6
Cahners Hall	B6
Churchill Hall	H6
Classroom Building	G4
Cushing Hall	B6
Dana Research Center	I5
Dockser Hall	G5
Dodge Library	G9
Ell Student Building (Auditorium)	G8
Ell Student Center (Student Lounge)	H8
Forsyth Building	H6
Forsyth Building Annex	I5
Hayden Hall	H7
Holmes Hall	H4
Hurtig Hall	H10
Kerr Hall (Faculty Center)	B6
Knowles Center (Gryzmish Hall)	F5
Knowles Center (Volpe Hall)	F4
Lake Hall	H4
Law School Extension	G4
11 Leon Street	J3
15 Leon Street	J3
Meserve Hall	I3
Mugar Life Sciences Building (Peabody Health Professions Center)	G9
Nightingale Hall	I5
Northeastern Arena	G12
Parker Building	G3
Peabody Center	H9
Richards Hall	G7
Ruggles (11, 15 Leon Street)	J3
Robinson Hall	I9
Stearns Center	F4
26-29 Tavern Road	G2

1982–1983 ACADEMIC CALENDAR (times and dates subject to change)

Fall Quarter 1982 Classes Begin Monday, September 27, 1982

FALL REGISTRATION DATES

Boston	5:00–8:00 p.m.	Tuesday-Friday, September 7–10
	9:00–12 Noon	Saturday, September 11
	5:00–8:00 p.m.	Monday-Thursday, September 13–16
Burlington	5:00–8:00 p.m.	Monday-Thursday, September 13–16
	12:00–3:00 p.m. & 5:00–8:00 p.m.	Tuesday, September 14
Framingham North H.S.	5:30–8:00 p.m.	Tuesday, September 7 and Monday, September 13
Norwood Jr. H.S. North	5:30–8:00 p.m.	Wednesday, September 8 and Monday, September 13
Revere (Abraham Lincoln School)	5:30–8:00 p.m.	Thursday, September 9 and Tuesday, September 14
Westwood H.S.	5:30–8:00 p.m.	Thursday, September 9 and Tuesday, September 14
Weymouth North H.S.	5:30–8:00 p.m.	Wednesday, September 8 and Monday, September 13
Fall Quarter Classes Begin		Monday, September 27
Columbus Day Observed	No Classes	Monday, October 11
Veterans Day	No Classes	Thursday, November 11
Thanksgiving Recess	No Classes	Thursday-Saturday, November 25–27
Final Examination Period for Fall Quarter		Monday-Saturday, December 13–18

Winter Quarter 1983 **Classes Begin Monday, January 3, 1983**

WINTER REGISTRATION DATES

Boston	5:00–8:00 p.m.	Monday-Thursday, December 6–9
	5:00–7:00 p.m.	Friday, December 10
Burlington	5:00–8:00 p.m.	Monday-Thursday, December 6–9
Framingham North H.S.	5:30–8:00 p.m.	Monday, December 6 and Tuesday, December 7
Norwood Jr. H.S. North	5:30–8:00 p.m.	Monday, December 6 and Wednesday, December 8
Revere (Abraham Lincoln School)	5:30–8:00 p.m.	Tuesday, December 7
Westwood H.S.	5:30–8:00 p.m.	Tuesday, December 7
Weymouth North H.S.	5:30–8:00 p.m.	Tuesday, December 7 and Wednesday, December 8
Christmas Vacation	No Classes	Monday-Saturday, December 20–January 1
Winter Quarter Classes Begin		Monday, January 3
Martin Luther King Jr.'s Birthday	No Classes	Saturday, January 15
Washington's Birthday	No Classes	Monday, February 21
Final Examination Period for Winter Quarter		Monday-Saturday, March 21–26
Spring Recess (or make-up period for lost snow days)		Monday-Saturday, March 28–April 2

Spring Quarter 1983 **Classes Begin Monday, April 4, 1983**

SPRING REGISTRATION DATES

Boston	5:00–8:00 p.m.	Monday-Thursday, March 14–17
	5:00–7:00 p.m.	Friday, March 18
Burlington	5:00–8:00 p.m.	Monday-Thursday, March 14–17
Framingham North H.S.	5:30–8:00 p.m.	Monday, March 14 and Tuesday, March 15
Norwood Jr. H.S. North	5:30–8:00 p.m.	Monday, March 14 and Wednesday, March 16
Revere (Abraham Lincoln School)	5:30–8:00 p.m.	Tuesday, March 15
Westwood H.S.	5:30–8:00 p.m.	Tuesday, March 15
Weymouth North H.S.	5:30–8:00 p.m.	Monday, March 14 and Wednesday, March 16
Spring Quarter Classes Begin		Monday, April 4
Patriot's Day Observed	No Classes	Monday, April 18
Memorial Day Observed	No Classes	Monday, May 30
Final Examination Period for Spring Quarter		Monday-Saturday, June 13–18
Commencement		Sunday, June 19

Summer Quarter 1983 **Classes Begin Monday, June 20, 1983**

REGISTRATION FOR ENTIRE SUMMER QUARTER

Boston	5:00–8:00 p.m.	Tuesday-Friday, May 31–June 3
Burlington	1:00–3:00 p.m. & 5:00–8:00 p.m.	Tuesday, May 31
	5:00–8:00 p.m.	Wednesday, June 1
Summer Quarter Classes Begin		Monday, June 20

REGISTRATION FOR SECOND FIVE-WEEK TERM

Boston	5:00–8:00 p.m.	Monday, July 18 and Tuesday, July 19
Burlington	5:00–8:00 p.m.	Monday, July 18
Independence Day Observed	No Classes	Monday, July 4
Labor Day Observed	No Classes	Monday, September 5
Final Examination Period for Summer Quarter		Held during last class session of each term

1983–1984 ACADEMIC CALENDAR (times and dates subject to change)

Fall Quarter 1983 Classes Begin Monday, September 26, 1983

Fall Quarter Classes Begin		Monday, September 26
Columbus Day Observed	No Classes	Monday, October 10
Veterans Day	No Classes	Friday, November 11
Thanksgiving Recess	No Classes	Thursday-Saturday, November 24–26
Final Examination Period for Fall Quarter		Monday-Saturday, December 12–17

Winter Quarter 1984 Classes Begin Tuesday, January 3, 1984

Christmas Vacation	No Classes	Monday-Monday, December 19–January 2
Winter Quarter Classes Begin		Tuesday, January 3
Martin Luther King Jr.'s Birthday	No Classes	Monday, January 16
Washington's Birthday	No Classes	Monday, February 20
Final Examination Period for Winter Quarter		Monday-Saturday, March 19–24
Spring Recess (or make-up period for lost snow days)		Monday-Saturday, March 26–31

Spring Quarter 1984	**Classes Begin Monday, April 2, 1984**	
Spring Quarter Classes Begin		Monday, April 2
Patriot's Day Observed	No Classes	Monday, April 16
Memorial Day Observed	No Classes	Monday, May 28
Final Examination Period for Spring Quarter		Monday-Saturday, June 11–16
Commencement		Sunday, June 17

Equal Opportunity Policy

Northeastern University is committed to a policy of providing equal opportunity to all. In all matters involving admissions, registration, and all official relationships with students, including evaluation of academic performance, the University insists on a policy of nondiscrimination.

Northeastern University is also an equal opportunity employer; it is institutional policy that there shall not be any discrimination against any employee or applicant for employment because of race, color, religion, sex, age, national origin, or on the basis of being a handicapped, but otherwise qualified, individual. Further, Northeastern will not condone any form of sexual harassment.

Inquiries concerning our equal opportunity policies may be referred to the University Title IX Coordinator/Compliance Officer for Section 504 of the Rehabilitation Act of 1973, Affirmative Action Office, 175 Richards Hall, 617-437-2133.

Emergency Closing of the University

Northeastern University has made arrangements to notify students, faculty, and staff by radio when it becomes necessary to cancel classes because of extremely inclement weather. Radio stations WBZ, WEEI, WHDH, WJDA, WRBB, WCOZ, WRKO, WLYN, WKOX, WHAV, WBCN-FM, WVBF-FM, WHUE, and WLLH will announce the University's decision to close.

Office of Services for the Handicapped

The Office of Services for the Handicapped (OSH) provides a variety of support services and general assistance to all Northeastern's disabled students and employees. The University's efforts to comply with the Rehabilitation Act of 1973 are coordinated by Ruth Bork, OSH Director, 5 Ell Center, (617) 437-2675.

Delivery of Services

The University assumes no liability, and hereby expressly negates the same, for failure to provide or delay in providing educational or related services or facilities or for any other failure or delay in performance arising out of or due to causes beyond the reasonable control of the University, which causes include, without limitation, power failure, fire, strikes by University employees or others, damage by the elements, and acts of public authorities. The University will, however, exert reasonable efforts, when in its judgment it is appropriate to do so, to provide comparable or substantially equivalent services, facilities, or performance, but its inability or failure to do so shall not subject it to liability.

The Northeastern University catalog contains current information regarding the University calendar, admissions, degree requirements, fees, and regulations, and such information is not intended to be and should not be relied upon as a statement of the University's contractual undertakings.

Northeastern University reserves the right in its sole judgment to promulgate

and change rules and regulations and to make changes of any nature in its program, calendar, admissions policies, procedures and standards, degree requirements, fees, and academic schedule whenever it is deemed necessary or desirable, including, without limitation, changes in course content, the rescheduling of classes, cancelling of scheduled classes and other academic activities, and requiring or affording alternatives for scheduled classes or other academic activities, in any such case giving such notice as is reasonably practicable under the circumstances.

We at Northeastern will do our best to make available to you the finest education we can provide, the most stimulating atmosphere in which to learn, and the most congenial conditions under which you may enjoy the learning experience. But the quality and the rate of progress of your academic career is in large measure dependent upon your own abilities, commitment, and effort. You will be a full participant in an educational partnership. We will and, indeed, can only make the opportunities available to you; it is up to you to take advantage of them.

This is equally true with your career upon graduation. We cannot guarantee that you will obtain any particular job; that will depend upon your own skills, achievement, presentation, and other factors such as market conditions at that time. Similarly, in many professions and occupations there are increasing requirements imposed by federal and state statutes and regulatory agencies for certification or entry into a particular field. These may change during the period of time when you are at Northeastern and they may vary from state to state. While we will be ready to help you find out about these requirements and changes, it is your responsibility to initiate the inquiry because we cannot know what your expectations and understandings are unless you tell us.

In brief, what we are saying to you is that we are here to offer you educational opportunities and choices and to assist you in finding the direction in which you want to steer your educational experience. But you are a partner in this venture with an obligation and responsibility to yourself.

Family Educational Rights and Privacy Act

In accordance with the Family Educational Rights and Privacy Act of 1974, Northeastern University permits its students to inspect their records wherever appropriate and to challenge specific parts of them when they feel it necessary to do so. Specific details of the law as it applies to Northeastern are printed in the *Student Handbook* and are distributed annually at registrations of University College and the graduate schools.

Fee Disclaimer

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time.

Accreditation

Northeastern University is accredited by the New England Association of Schools and Colleges, Inc., which accredits schools and colleges in the six New England states. Accreditation by the Association indicates that the institution has been carefully evaluated and found to meet standards agreed upon by qualified educators.

the university

Founded in 1898, Northeastern University is incorporated as a privately endowed, nonsectarian institution of higher learning under the General Laws of Massachusetts. The State Legislature, by special enactment, has given the University general degree-granting powers. The University is governed by a Board of Trustees elected by and from the Northeastern University Corporation, which is composed of almost 200 distinguished business and professional men and women.

From its beginning, Northeastern University has had as its dominant purpose the discovery of community educational needs and the meeting of these needs in distinctive and serviceable ways. The University has not duplicated the programs of other institutions, but has sought to pioneer new areas of educational service.

A distinctive feature of Northeastern University is its Cooperative Plan, initiated by the College of Engineering in 1909 and subsequently adopted by the Colleges of Business Administration (1922), Arts and Sciences (1935), Education (1953), Pharmacy (1962), Nursing (1964), Boston-Bouvé College (1964), Criminal Justice (1967), Lincoln College's Engineering Technology Programs (1971), and by University College in a special pilot program (1980). As an educational method, the Cooperative Plan offers students the opportunity to gain valuable practical experience as an integral part of their college programs, and also provides the means by which they may contribute to the financing of their education. The Plan has been extended to the graduate level in engineering, mathematics, rehabilitation administration, professional accounting, business administration, and law.

In the field of adult education, programs of study have been developed to meet a variety of needs. Since 1906, evening curricula have been offered leading to the bachelor's degree. Programs in the arts and sciences, engineering, various fields of business, law enforcement and security, and other areas have been carefully planned to serve mature students who are employed full time during the day and want to broaden their educational background by part-time study. All formal courses of study leading to degrees through evening

programs are approved by the Basic College faculties concerned and are subject to the same quantitative and qualitative standards as the regular day curricula.

UNDERGRADUATE COLLEGES

College of Arts and Sciences

The College of Arts and Sciences offers majors in the arts and sciences leading to the Bachelor of Arts or Bachelor of Science degree. Curricula are normally four years in length on a full-time plan or five years in length on the Cooperative Plan.

Boston-Bouvé College of Human Development Professions

Boston-Bouvé College offers programs of study leading to the degree of Bachelor of Science in Education in the fields of elementary education, human services, physical education, recreation and leisure studies, school and community health education, secondary education, and speech-language pathology and audiology, as well as a Bachelor of Science in Physical Therapy.

College of Business Administration

The College of Business Administration offers programs of study in principal fields of business leading to the Bachelor of Science degree in Business Administration.

The College also sponsors a Center for Management Development, which annually conducts intensive programs designed to provide professional growth for experienced managers. The plan of instruction, based on a modification of the Northeastern cooperative program, permits the participants to maintain their job responsibilities during the five-month period of the course. The Management Development Program is conducted at Andover, Massachusetts, on the campus of Phillips Academy. The Center also conducts management workshops, scheduled on 12 Fridays and offering four core areas of management study.

The Bureau of Business and Economic Research provides administrative assistance to research projects carried out under faculty leadership and supervision.

College of Computer Science

The Bachelor of Science degree in Computer Science is offered.

College of Criminal Justice

The College of Criminal Justice offers a full-time day curricula on the Cooperative Plan, leading to the degree of Bachelor of Science.

College of Engineering

The College of Engineering offers five-year cooperative curricula in civil (including an environmental engineering option), mechanical, electrical (including a power systems option and a computer engineering option), chemical, indus-

trial engineering, and information systems leading to the degree of Bachelor of Science with specification according to the engineering department in which the student qualifies. A more general program without specification leading to the Bachelor of Science degree is offered in which students design their curriculum around a core of science, engineering science, and engineering courses. For highly qualified students, most departments offer a five-year program leading to both Bachelor's and Master's degrees; students carry course overloads beginning in the third year. The College also offers, during evening hours, part-time programs leading to Bachelor of Science degrees in Civil, Mechanical, and Electrical Engineering, extending over eight years and meeting the same qualitative and quantitative standards of scholarship as the day curricula.

Lincoln College

Lincoln College offers engineering technology programs leading to the Associate in Engineering, the Associate in Science, and the Bachelor of Engineering Technology degrees. These programs are made available as:

(a) A full-time day curricula on the Cooperative Plan leading to the degree of Bachelor of Engineering Technology (B.E.T.) in Mechanical or Electrical Engineering.

(b) A part-time evening program including pretechnology preparatory courses and degree programs leading to the Associate in Engineering (A.E.); and the Bachelor of Engineering Technology (B.E.T.) in Civil, Mechanical, or Electrical Engineering.

(c) Lincoln College part-time students whose work schedule does not permit them to attend regular evening classes may register for a maximum of eight quarter hours of course work per quarter in the Lincoln College day program.

Registration materials will be available Monday through Friday in Room 408 Churchill Hall, Boston Campus only, during the week preceding the start of each quarter. The day class schedule will not be available at other campus locations. The Registrar will not accept registration materials for day classes without the approval of the Director of Lincoln College.

The day B.E.T. program is designed to meet the needs of the high school graduate or the student transferring from a community college or technical institute, and who desires the full-time day curricula on the Northeastern Cooperative Plan.

In addition to its traditional curricula, Lincoln College Evening School offers interdisciplinary programs providing technological and professional development opportunities to meet special needs of the part-time student. These programs are designed to provide trained people for ready assimilation by the engineering field and to give students the opportunity to prepare for the challenge of interfacing technology and society.

College of Nursing

The College of Nursing offers programs leading to a Bachelor of Science degree in nursing, with special programs designed for licensed practical nurses or registered nurses.

College of Pharmacy and Allied Health Professions

The College of Pharmacy and Allied Health Professions offers five-year co-operative curricula leading to the degree of Bachelor of Science in Pharmacy, Bachelor of Science in Respiratory Therapy, Bachelor of Science in Toxicology, and to the Bachelor of Science degree with majors in medical laboratory science and medical record administration. Associate degree programs are offered in medical laboratory technology, respiratory therapy, and dental hygiene. The College has academic responsibility and, in cooperation with the medical schools and teaching hospitals in the Boston area, offers the professional program for physician assistants.

University College

University College, so called because it draws upon the resources of the other colleges of the University, offers part-time day and evening programs in arts and sciences, business administration, law enforcement, education, health professions, and therapeutic recreation service programs, leading to the Associate in Science, Bachelor of Arts, and Bachelor of Science degrees. It does not duplicate the offerings of the day colleges, but provides curricula which cut across traditional subject-matter areas to meet the particular needs of adult students. Students may pursue a degree or simply take courses, based on needs and interests, up to a total of 39 or 40 quarter hours of credit. Courses are offered in Boston as well as in Burlington, Framingham, Milford, Revere, Weymouth, Brockton, Norwood, Marshfield, Sandwich, Belmont, Westwood, Dedham, Lynnfield, and Marlborough.

Adult Day Programs refer to University College courses offered Monday through Friday, 9:00 a.m. to 5:00 p.m., to meet the needs of adults with family or other obligations who wish to engage in part-time study during the day. In addition to the daytime offerings of regular University College credit courses, Adult Day Programs also offer workshops and conferences, sometimes over weekends, with the option for credit. Adult Day Programs are offered primarily on the Boston and Burlington Campuses, with a limited number of courses offered at other off-campus locations.

Students may enroll as degree candidates or elect single courses appropriate to their needs and interests. Courses are scheduled in the day and evening at the Boston Campus, Suburban Campus in Burlington, and other off-campus locations near Boston.

GRADUATE SCHOOLS

Arts and Sciences

The Master of Arts degree may be earned in Economics, English, History, Political Science, Psychology, Sociology, and Social Anthropology. The Master of Science degree is available in Biology, Chemistry, Economics Policy and Planning, Mathematics, and Physics. The Master of Science in Health Science and the Master of Public Administration degrees are also offered. In addition, there are an advanced Literary Study Program leading to the Certificate of Advanced Graduate Study and programs leading to the Doctor of Philosophy degree in Biology, Chemistry, Economics, Mathematics, Physics, Psychology, and Sociology. An interdisciplinary Ph.D. Program is offered in Forensic Chemistry with the College of Criminal Justice. Most programs may be completed through either full- or part-time study.

Boston-Bouvé College of Human Development Professions

The Master of Science degree may be earned, with specialization in Physical Education, Physical Therapy, or Recreation and Leisure Studies. Graduate courses in Health Education are available as electives within the College and for special students. Programs may be completed through full- and part-time study.

The Master of Education degree may be earned, with specialization in Community Mental Health Counseling, Curriculum and Instruction, Early Childhood Education, Educational Administration, Educational Research, Human Development Industrial Counseling Rehabilitation, Special Education School and College Counseling, or Speech-Language Pathology and Audiology. The Certificate of Advanced Graduate Study is offered in Counselor Education, Curriculum and Instruction, Educational Administration, Rehabilitation Counseling, and Social Sciences. The Doctor of Education degree may be earned in Administration, with specialization in Counselor Education, Educational Administration, or Rehabilitation and Special Education.

The master's degree program in Speech-Language Pathology and Audiology is accredited by the Education and Training Board of the Boards of Examiners in Speech Pathology and Audiology.

Business Administration

A Master of Business Administration degree may be earned. The Graduate School of Business Administration offers a variety of programs to meet the needs and schedules of graduate business students. For those interested there are two program alternatives: a twenty-one-month Management Intern Program, which includes a six-month, paid professional internship; or a two-year traditional full-time program, which may include administrative or teaching assistantship opportunities. Individuals who wish to continue their full-time job responsibilities while earning an M.B.A. degree may consider the evening part-time program of study, the eighteen-month Executive M.B.A. Program for upper-

level managers, or the accelerated part-time High Technology M.B.A. for qualified technical specialists. The Master of Science degree in professional accounting is an intensive, full-time program specifically designed for liberal arts and other nonaccounting majors. In addition, there is a Program for Advanced Study in Business Administration leading to the Certificate of Advanced Study in Business Administration.

Criminal Justice

The College of Criminal Justice offers both full- and part-time programs leading to a Master of Science degree in Criminal Justice and a Master of Science degree in Forensic Chemistry. Students enrolled in the Master of Science program in Criminal Justice choose among three major concentrations of study—administration and planning, criminology, and correctional counseling. The Master of Science program in Forensic Chemistry provides an integrated survey of forensic science as utilized in criminalistics, toxicology, and related professional fields. An interdisciplinary Ph.D. program in Forensic Chemistry is also offered with the College of Arts and Sciences, with specialization in Forensic Toxicology, Forensic Materials Science, or Forensic Analytical Chemistry. Students in either program attend classes during late afternoon and evening hours.

Engineering

Master of Science degrees are offered with course specifications in the fields of Civil, Chemical, Electrical, Industrial, Mechanical, Transportation, Engineering Management and Information Systems. A six-year program leading to both a Bachelor's and Master's degree is offered in Electrical Engineering, Mechanical Engineering, and Power Systems. Professional Engineers degrees are offered in Electrical, Industrial, and Mechanical Engineering. We also offer a Women in Engineering Program. Ph.D. degrees are offered in Civil, Chemical, Electrical, and Mechanical Engineering. A Doctor of Engineering degree in Chemical Engineering is offered in addition to the Ph.D.

Law

The School of Law offers a full-time program of professional instruction leading to the degree of Juris Doctor (J.D.). The three-year curriculum includes 12 months of professional experience in law offices, governmental agencies, or other law-related employment. There are no courses for part-time or evening students.

Pharmacy and Allied Health Professions

The Master of Science degree is offered in Clinical Chemistry, Hospital Pharmacy, Medical Laboratory Science, Medicinal Chemistry, Pharmacology, and Radiopharmaceutical Science. The Ph.D degree is offered in Biomedical Science with specialization in Medical Laboratory Science, Medicinal Chemistry, Pharmaceutical Science, or Pharmacology. An interdisciplinary doctoral degree

is available in Forensic Chemistry as well as a graduate program in Clinical Pharmacy which leads to the degree Doctor of Pharmacy (Pharm. D).

Professional Accounting

A five-quarter curriculum leading to the degree of Master of Science in Accounting.

Some of the above programs are offered on the Cooperative Plan; others provide teaching and research fellowships for able candidates. The graduate schools are under the jurisdiction of the basic college deans.

CENTER FOR CONTINUING EDUCATION

The Center for Continuing Education was established to relate the University to the needs of its community in a period of accelerated change. Its programs are composed of seminars, conferences, institutes, forums, and a wide variety of special courses designed to serve specific needs. The Division of Special Programs, working cooperatively with trade associations and professional societies, offers a wide variety of programs dealing with current needs and problems. Through its Division of Community Services, working with governmental agencies and community organizations, the Center is becoming increasingly involved in social problems on both the local and national levels.

Many of these programs are conducted at Henderson House, Northeastern University's conference center in Weston, Massachusetts.

OFFICE OF LEARNING RESOURCES

The Office of Learning Resources provides faculty, students, and staff with a variety of instructional services, equipment, and learning facilities.

The Learning Center furnishes students with individualized study and language lab facilities for remedial, supplementary, or enrichment purposes in many subject areas and in many formats—programmed texts, audiotapes, videotapes, and sound filmstrips, among others. A listening lounge, equipped with a stereophonic sound system, supplies a large selection of classical and popular prerecorded music. Students may use all facilities independently or to complete class assignments at no cost during day, evening, and weekend hours.

The Learning Resources Center is located in 406 Dodge Library and is open seven days a week. Telephone 437-2465 for further information.

The Media Production Laboratory provides facilities for both students and faculty for producing original materials, such as overhead transparencies, audiotapes, illustrations, slides, posters, and charts. Training is given in the use of all equipment, including that used for television production.

Campus Media Services makes available all types of audiovisual and video equipment and instructional materials for the support of classroom instruction on a prescheduled basis. Certain equipment is reserved for student use, and

students may borrow instructional materials with faculty approval. A catalog of all instructional materials is available at no charge.

The Instructional Materials Center, which acquires and maintains the collection of University-owned instructional materials, also provides a rental service for 16mm films and videotapes obtained from outside sources. Faculty who would like to evaluate instructional materials before purchase may do so through its preview service and facilities.

The Instructional Development Center assists individual faculty with specifying instructional goals, reviewing related literature and materials, examining alternative teaching strategies, producing learning materials, and evaluating course effectiveness. Its training in presentation and teaching techniques is complementary to its basic function of developing instructional units and courses.

DAY PROGRAMS FOR ADULTS

These programs were developed to meet the needs of adults who wish to engage in part-time study during the day only. Noncredit courses and undergraduate and graduate degree programs are offered at the Boston and Burlington campuses. Included are courses from the graduate Boston-Bouvé College of Human Development Professions, the Graduate School of Arts and Sciences, University College, and the Center for Continuing Education. A Human Relations and Adult Counseling Program is also offered.

AFFILIATED PROGRAMS

Dental Hygienists

The Forsyth School for Dental Hygienists conducts a two-year program of dental hygiene education and general education in cooperation with Northeastern University. Graduates receive the Certificate in Dental Hygiene from Forsyth and the degree of Associate in Science from Northeastern University. After receiving the Associate degree, students may pursue the Bachelor of Science degree from University College on a part-time basis.

Aeronautical Technology

Lincoln College conducts full-time day programs in Aeronautical Technology in which the student earns the Associate in Science degree and may become licensed by the Federal Aviation Administration with commercial, instrument, and instructor pilot ratings.

Health Record Administration

The University, in affiliation with several area hospitals, offers a three-year part-time evening program leading to certification in Health Record Administration for students who already hold a Bachelor's degree and wish to qualify for the professional examination leading to registration as a record librarian.

Medical Technologists, Cytotechnologists, Hematologists

In cooperation with area teaching hospitals, Northeastern University offers a full-time day program on the Cooperative Plan leading to the degree of Bachelor of Science with concentration in Medical Technology.

Bachelor of Science degree programs in Medical Technology and Hematology and an Associate degree in Cytotechnology are offered on a part-time basis by University College in cooperation with several approved hospital schools.

Nurses

Northeastern University offers instruction in the sciences, humanities, and social studies for student nurses working for their Associate or Baccalaureate degree.

Physician Assistants

In cooperation with the Massachusetts Medical Society, Northeastern offers an 18-month program for the primary care physician assistant. Clinical rotations, supplemental to courses taken on campus, take place at Boston-area hospitals.

Radiologic Technologists

University College, in collaboration with several American Medical Association-affiliated hospitals in the New England area, conducts a program leading to eligibility for certification as a registered Radiologic Technologist and the Associate in Science degree. The program is accredited by the Joint Review Committee on Education in Radiologic Technology of the American Medical Association.

Respiratory Therapists

This program is conducted by the College of Pharmacy and Allied Health Professions in affiliation with local hospitals.

buildings and facilities

Main Campus

The main campus of Northeastern University is located at 360 Huntington Avenue in the Back Bay section of Boston. Many of the city's famous cultural, educational, and philanthropic institutions are situated in the Back Bay, including the Museum of Fine Arts, Symphony Hall, Horticultural Hall, the Isabella Stewart Gardner Museum, the Harvard teaching hospitals, and many schools and colleges. Most are within walking distance of Northeastern University.

Major transportation facilities serving the Boston area are Logan International Airport, two rail terminals, bus terminals serving inter- and intrastate lines, and MBTA subway-bus service within the metropolitan-suburban area. There is a subway stop in front of the campus. For motorists, the best routes to the campus are the Massachusetts Turnpike (Exit 22) and Route 9, of which Huntington Avenue is the intown section.

The campus of 50 acres is divided by Huntington Avenue, with the main educational buildings on one side and dormitories on the other. The principal buildings, all of which have been constructed since 1938, are of glazed brick in contemporary classic style. Some are interconnected by underground passageways.

Carl S. Ell Student Center

The Carl S. Ell Student Center provides facilities for student recreation and for extracurricular activities. The Alumni Auditorium, with a seating capacity of 1,300, is part of the Center. Also included are special drama facilities, a ballroom, main lounge, fine arts exhibition area, student offices, conference rooms, and a dining area seating more than 1,000.

University Library System

The University Library System includes the Dodge Library and the three graduate libraries: Chemistry, 112 Hurtig Hall, which includes Chemical Engineering, Biology, Pharmacy, and the Health Sciences; Physics/Electrical Engineering, 324 Dana Hall; and Mathematics/Psychology, 531 United Realty Building. The Suburban Campus Library supports the programs at Burlington. Other collections are Marine Science and Maritime Studies Center at Nahant, Center for Management Development at Andover, and Aeronautical Technology at Norwood. There is also the Law Library, located in the Knowles Center, and the Curriculum Resources Library in Cahners Hall.

The University Library collections number more than 464,099 bound volumes and 500,000 microform volumes. The periodical titles number 4,000, additional continuation titles 1,243, and sound recordings 10,953.

1. The Reference Collection in the Cabot Reading Room on the main floor of the Dodge Library contains 20,000 volumes. This collection is of major importance to anyone using the library. The researcher should be aware of the source books, handbooks, bibliographies, and similar aids before beginning an investigation of the literature.

   The Reference Division includes the Government Documents Collection located in 14 Dodge, and the Microforms Collection located in 108 Dodge. Additional sources of information are the Business Services, Technical Reports, Annual/Company Reports, and the Information File for pamphlet materials.
2. The Periodical Collection in the Webster Reading Room on the main floor consists of Indexing and Abstracting Services, and the current periodicals mainly in literature, humanities, social sciences, and general science, as well as foreign and domestic newspapers.

   This collection supports the Reference Collection and updates the General Collection by encompassing the latest developments in all fields of knowledge.

   The Periodical Stacks are adjacent to the collection and are serviced by the library staff.
3. The General Collection is located on the three floors and two stack levels of the Dodge Library indicated by posted floor plans and guides available at the Information Desk.
4. The Reserve Book Collection is located in 204 Dodge. This is an important and widely used collection of textbooks and assigned reading to support the classroom lecture and laboratory, and for further in-depth information.
5. The Public Catalog located on the main floor includes author, title, and subject cards for the foregoing collections, except for documents, technical reports, and complete entries for periodicals, which will be found in catalogs in those areas. The Public Catalog includes both the Dewey Decimal classification and the Library of Congress classification.
6. The Circulation Department manages the organization of the General Collection. Materials are charged out and returned at the Circulation Desk. A daily computer printout of items on loan is available to assist in locating books not found on the shelves.
7. The Inter-Library Loan Department is located in 18 Dodge. This service should be used for materials not available in the system and for serious research.
8. The Music Reference Service is located in 406 Dodge. This collection of books, scores, records, and tape cassettes is for assigned listening and personal enjoyment. The collection contains both music and spoken word.
9. The Learning Center, 406 Dodge, is a service for programmed and language instruction utilizing audio/visual/video equipment teaching programs to support classroom work and independent study.
10. It should be understood that the Divisional Libraries, the Burlington Campus Library, and the Law School Library have the same services and card

catalogs as the main Dodge Library with respect to other specific academic disciplines.

LIBRARY HOURS

Dodge Library

Mon.–Thurs.	7:45 a.m. to 10:00 p.m. (10:00 p.m. to midnight)*
Friday	7:45 a.m. to 7:30 p.m.
Saturday	12:00 noon to 4:00 p.m. (4:00 p.m. to 10:00 p.m.)*
Sunday	12:00 noon to 4:00 p.m. (4:00 p.m. to midnight)*

* References and Periodicals; for study only.

Divisional Libraries

Mon.–Thurs.	8:30 a.m. to 10:00 p.m.
Friday	8:30 a.m.–7:30 p.m.
Saturday–Sunday	Closed

Suburban Campus Library, Burlington

Mon.–Thurs.	8:30 a.m. to 9:00 p.m.
Friday	8:30 a.m. to 5:00 p.m.
Saturday	8:30 a.m. to 1:00 p.m. (alternate Saturdays)
Sunday	Closed

Cabot Physical Education Center

The Godfrey Lowell Cabot Physical Education Center is one of the best equipped in New England. It contains four basketball courts, an athletic cage, a small gymnasium, and a Nautilus room, as well as administrative offices for the Department of Men's Athletics and for the Physical Education Department of the Boston-Bouvé College of Human Development Professions.

The Barletta Natatorium houses a 105-foot swimming pool, a practice tank for the crew, handball/racquetball courts, and shower and dressing facilities.

Dockser Hall

Charles and Estelle Dockser Hall, completed in 1968, houses a large gymnasium, dance studio, motor performance laboratory, library, community recreation laboratory, folk arts center, darkroom, recreation resources area, locker rooms, offices, classrooms, conference room and lounge, storage facilities, and a research laboratory.

SUBURBAN FACILITIES

Suburban Campus

The Suburban Campus, located near the junction of Routes 128 and 3 in Burlington, Massachusetts, was established to meet the needs of individuals and of industry in the area.

In addition to graduate courses in engineering, physics, mathematics, business administration, science, education, and the arts, portions of undergraduate programs leading to the Associate and Bachelor's degrees, special programs for adults, and noncredit state-of-the-art programs are offered.

Henderson House

The University's conference center, Henderson House, is located in Weston, Massachusetts. The Center for Continuing Education conducts short-term courses, seminars, and special institutes for business, professional, and research groups. Henderson House is 12 miles from the main campus.

Warren Center

The Warren Center serves as a practical laboratory for students in Boston-Bouvé College of Human Development Professions. Its athletic fields and tennis courts, ropes course, natural setting of lake, woods, fields, streams, winterized cottages, and Hayden Lodge provide year-round opportunities for outdoor learning twenty-five miles from the Boston campus. Courses, conferences, seminars, and workshops are conducted at the Center throughout the year and thus serve University and community needs.

Marine Science and Maritime Studies Center

The Marine Science and Maritime Studies Center at Nahant, Massachusetts, located about 20 miles northeast of Boston, is a research and instruction facility engaged primarily in studies of marine biology and oceanography. The Institute is operated all year.

lincoln college administration

Administrative Officers

Thomas E. Hulbert, B.Mgt.E., M.S.
Director
Jacob Wiren, B.S., M.S., P.E.
Assistant Director
Rasma Galins, B.S.
Assistant to the Director
David A. Fraizer, B.S.
Counselor

Student Counseling Staff

David A. Fraizer
Administrative Coordinator

Robert J. Averill, B.S., M.S.
Boreslaw P. Berestecky, B.S.M.E., M.Ed.
Philip W. Dunphy, B.S., M.Ed.
Peter Franks, B.A., M.Ed.
Richard E. Sprague, B.S., B.B.A., M.B.A., Ed.M.
Kenneth S. Woodard, B.S., M.E., A.G.I.I.G.I. (Federal)

Committee on Regulations and Discipline

Director, Lincoln College, *Chair*

Kenneth S. Woodard
David A. Fraizer
Rasma Galins
President, Adult Student Council

Academic Standing Committee

Rasma Galins, *Chair*

David A. Fraizer
Jacob Wiren
Ernest E. Mills
Louis J. Nardone

Academic Advisory Council

Director, Lincoln College, *Chair*
Jacob Wiren, *Vice Chair*

Edward Bobroff
Leroy M. Cahoon
Rasma Galins
Francis R. Hankard
Walter Messcher
Ernest E. Mills
Louis J. Nardone
Kenneth S. Woodard

Industrial Advisory Committee

Mr. Roger Alvey, President
Codex Book Company
Mr. Adolf W. Arnold, President
Engineered Advertising, Inc.
Mr. Leon Berig
M.B.T.A. (Retired)
Prof. Leroy Cahoon
Civil Eng. Tech. Coordinator
Lincoln College
Mr. Stanley T. Dingman
Engineered Advertising, Inc.
Dr. John H. Eskesen
General Electric Company
Mr. Per Holst
The Foxboro Company
Prof. Borah Kreimer
Lincoln College
Mr. Demetre P. Ligor
Applied Measurements, Inc.
Prof. Ernest E. Mills
Mech. Eng. Tech. Coordinator
Lincoln College
Prof. Louis J. Nardone
Elect. Eng. Tech. Coordinator
Lincoln College
Mr. Milton J. Smith, President
Trim Alloys, Inc.
Mr. Dan Swallom
AVCO Everett Research Lab.
Mr. Jerrold Zimmerman
Chief Engineer
Honeywell Inc.

Curriculum Advisory Committee

Director, Lincoln College
(Academic Administration)
Chair
Jacob Wiren, B.S., M.S., P.E.
Vice Chair
Rasma Galins, B.S.
Secretary
Kenneth S. Woodard, B.S., M.S.

Robert J. Averill, B.S., M.S.
(Circuit Theory & Trans. in Linear Systems)
Ralph S. Blanchard, Jr., B.S., M.S., P.E.
(Mechanical Engineering Electives)
Edward Bobroff, B.M.E.
(Program Consultant, Mathematics)
Eugene G. Branca, S.B., S.M.
(Basic Mathematics)
Franklyn K. Brown, B.S., M.Ed.
(Engineering Design)
Leroy M. Cahoon, B.S.C.E., M.S., P.E.
(Program Consultant, Civil Engineering Technology)
Robert W. Case, Ph.D.
(Coordinator, Day Mathematics)
Roger T. Connor, A.B., M.Ed.
(Course Consultant, Calculus)
William V. Durante, B.S., M.Ed., M.A.
(Freshman Mathematics)
William D. Finan, A.B., M.A., D.Ed.
(Introductory Mathematics)
Peter D. Gianino, B.S., M.S.
(Differential Equations)
David Goldberg, B.S., M.S.E.E., M.S.E.M.
(Electrical & Electronic Graphics)
Francis R. Hankard, S.B., M.A.
(Program Consultant, Physics)
Joseph J. Hansen, A.B., M.B.A.
(Mathematics for Business Mgmt.)
John Kaczorowski, Jr., B.S., M.S.
(Electronic Labs.)
George F. Kent, B.S., M.S., P.E.
(Materials)
Robert S. Lang, B.S., Ed.M.
(Engineering Graphics)
Demetre P. Ligor, B.S.E.E., P.E.
(Course Consultant, Physics)
Bertram S. Long, B.S., M.S., M.E.
(Stress Analysis, Adv. Stress Analysis)
Anton Mavretic, B.S., M.S., Ph.D.
(Linear Active Cir. Des., Electronics, & Prin. of Comm. Systems)
Robert L. Meserve, B.S., M.S.
(Fluid Mechanics)
Walter Messcher, B.M.E., M.S.
(Program Consultant, Computer Technology)
Ernest E. Mills, B.S., M.S., P.E.
(Program Consultant, Mechanical Engineering Tech., Day and Evening Programs)
Louis J. Nardone, B.S., M.S., P.E.
(Program Consultant, Electrical Engineering Technology, Day and Evening Programs)
Charles H. Price, Jr., B.S.E.E., M.S.E.E.
(Analog, Digital & Hybrid Computers, Digital Systems)
Ralph W. Sexton, B.S., M.S.P.E.
(Mechanical Tech. Laboratory)
Raimundas Sukys, B.S., M.S.
(Pulse Circuits, Integrated Circuits)
Joel Weinstein, B.S.
(Microprocessor Hardware)
Albert G. Wilson, Jr., B.S. C.E., M.S., P.E. (Mass.), S.E. (Illinois)
(Statics and Dynamics)

Office Staff

Karen D. Midgley, Secretary
Elsie Chan, Secretary of Exams
Rosanne L. Bogan, Secretary of Records
Janet A. Abdel-Rehim, Secretary

the role and scope of lincoln college

Purpose

Lincoln College is charged with the responsibility for developing and offering college-level courses and curricula of an applied-science or technological nature. Its purpose is to assist professional personnel, qualified to deal with the applications and uses of the biological, natural, and physical sciences in better meeting community needs. The programs of study conducted by the College have in common the following purposes and characteristics:

1. The programs of instruction offer the student the opportunity to prepare for activities allied to the fields of engineering, science, or medicine, but are more specialized than those required to prepare a person for full professional responsibilities.
2. The programs of instruction are more concise and more completely technological in content than professional curricula, although they are concerned with the same general fields of scientific, engineering, industrial, or clinical specialization.
3. The programs of instruction are based upon principles of science, and include post-secondary school mathematics to provide the tools to achieve the technological objectives of the curricula.
4. Emphasis is placed upon the use of rational processes in converting theories and ideas into practical techniques, procedures, and products.
5. Extensive training for artisanship or craftsmanship is not included within the scope of the technological education programs.
6. Graduates from the Associate degree programs have opportunities for educational work leading to the Bachelor of Engineering Technology and Bachelor of Science degrees.

Technology and the Technologist

Scientific and technological skills range over a broad spectrum, from extremely simple craftsmanlike activity to highly complex and abstract activity. At one end of the spectrum is the professional whose work is mostly theoretical in character. He or she studies, reasons, and visualizes how new knowledge may be used in the development of solutions to technical problems. This person usually is not completely knowledgeable in the detailed procedures used by the skilled craftsman who executes the ideas, procedures, and designs.

The technologist is the pivot-person on the professional-technologist-craftsman team. The technologist usually works with the professional engineer, sci-

entist, doctor, supervisor, and craftsman in converting knowledge of scientific theories and practical craftsmanship into products, procedures, and techniques.

When employed in research, design, or development, the technologist usually acts as direct supporting personnel to the professions. Functioning in a capacity related to production, operation, testing, or control, he or she usually follows a course prescribed by a professional, but may not work closely under the professional's direction. If installation, maintenance, or sales are the areas of responsibility, the technologist is frequently performing a task that would otherwise have to be performed by the professional, thereby assuming the more routine professional functions demanded by our increasingly scientific and technical society.

In executing all functions, the technologist is normally required to use a high degree of rational thinking and to employ post-secondary school mathematics and the principles of the biological, natural, and physical sciences. The skilled technologist works with the mind as well as the hands, and considers why, as well as how, things work. The technologist must effectively communicate technical and scientific information mathematically, graphically, and linguistically.

The Need for Technologists

Our present technological age, with its exploding accumulation of new information and discoveries in the physical, natural, and life sciences, has increased the need for people with specialized training in science and technology. Experts have recently estimated that in order to meet expanding needs, the number of students graduating from the nation's professional schools must double—a goal which is improbable in the near future.

The most reasonable alternative is to make our professional manpower most efficient by providing assistance in the form of specially trained technologists. Manpower experts believe that the present ratio of less than one technologist to each professional should ideally be nearer five to one.

Opportunities for technologists are increasing. The technologist's employment opportunities are varied and include positions in health and public service organizations; atomic energy and electric power industries; metal fabricating industries; local, state, and Federal government agencies; the armed forces; aerospace industries; chemical, petroleum, plastics, and metal industries; and transportation and communication industries among others.

PROGRAMS OF INSTRUCTION

Recognizing the growing need for technicians and technologists and their expanding role in modern society, Lincoln College offers Pre-Technology Preparatory Courses and degree programs leading to the Associate in Engineering (A.E.), Associate in Science (A.S.), and Bachelor of Engineering Technology (B.E.T.) degrees as follows:

Pre-Technology

Introductory Mathematics, Basic Mathematics, Physics, and English ..... pages 66–67

Reading Improvement Program (noncredit) ..... page 67
Programmed Study Review Courses (noncredit) ..... page 67

Aeronautical Technology

Aeronautical Technology (A.S. degree)—2 years (days) ..... page 68

Civil Engineering Technology

Architectural Engineering Technology (A.E. degree) ..... page 70
Environmental Engineering (A.E. degree) ..... page 71
Structural Engineering Technology (A.E. degree) ..... page 72
Surveying and Highway Engineering Technology (A.E. degree) ..... page 74
Civil Engineering Technology (B.E.T. degree) ..... page 75

Electrical Engineering Technology

Electrical Engineering Technology (A.E. degree) ..... page 78
Electrical Engineering Technology (B.E.T. degree) ..... page 79
Electrical Engineering Technology (B.E.T. degree) ..... page 81
(Day Cooperative Curriculum)

Mechanical Engineering Technology

Mechanical Engineering Technology (A.E. degree) ..... page 83
Mechanical Engineering Technology (B.E.T. degree) ..... page 84
Mechanical Engineering Technology (B.E.T. degree) ..... page 87
(Day Cooperative Curriculum)

Interdisciplinary Science and Engineering Technology Programs

Computer Technology (A.E. degree) ..... page 89
Computer Technology (B.E.T. degree) ..... page 90
Mechanical-Structural Engineering (B.E.T. degree) ..... page 92

COLLEGE OF ENGINEERING

Part-time Electrical, Civil, and Mechanical Engineering Programs (B.S. degree)

These programs are designed for fully qualified young men and women who:

1. because of family responsibilities must continue to be gainfully employed full time during the day, but who wish to advance by devoting leisure time to their own professional development;
2. were in the top half of their high school class, but at graduation were financially unable to continue their education at the college level; those who did not enjoy top-half standing may require refresher study;

3. realize that the most effective way to achieve their full potential in these days of specialization is to earn a college degree.

All courses in these part-time curricula are identical with those offered in the five-year, day cooperative programs and are taught by the same faculty.

The University reserves the right to withdraw, modify, or add to the courses offered or to change the order or content of courses in any curriculum.

Admission Requirements for the College of Engineering

It is important that applicants for admission to the College of Engineering complete the full sequence of secondary school courses in English, Mathematics, and Science. The following subjects should be included: English (four years), Physics or Chemistry, Algebra (through quadratics), Plane Geometry, and Trigonometry.

Admission testing requirements may be met in one of three ways:

1. by submitting the results of the College Board Scholastic Aptitude Test previously completed;
2. by writing the College Board Scholastic Aptitude Test during the current year; the Committee on Admissions provides full information about the Scholastic Aptitude Tests;
3. by completing a special battery of tests in the Northeastern University Counseling and Testing Center, Room 302, Ell Student Center.

A transfer student applying for advanced standing need not complete testing.

In evaluating the credentials of applicants, the Committee on Admissions takes into account additional study which may have been completed since secondary school and, where relevant, armed forces experience.

Applying for Admission to the College of Engineering

Applications for freshman admission and admission with advanced standing may be obtained by writing to the Department of Admissions, 150 Richards Hall, or they may be secured during an admissions interview.

A personal interview is not required, but all candidates are welcome to make an appointment with an admissions counselor. Interviews may be scheduled from 8:30 a.m. to 4:00 p.m., Monday through Friday, and on Saturday from 9:00 to 11:30 a.m.

The candidate will be notified of the decision of the Committee on Admissions as soon as all credentials have been received and evaluated.

Candidates who have successfully completed courses at other institutions and who wish to transfer to Northeastern should read the following information concerning special transfer programs.

Civil and Electrical Engineering Transfer Programs for Associate Degree Graduates

Students with an Associate degree from an (ABET) accredited technical institute, community college, or junior college with a 2.5 cumulative average or

better (C = 2.0) will be considered for admission to a special transfer program and complete the civil or electrical engineering degree in five years. Students whose Associate degree program did not include a minimum of one year of both calculus and physics will not be eligible for entry at this level.

Civil, Electrical, and Mechanical Engineering Transfer Programs for Bachelor of Engineering Technology Graduates

Students with a Bachelor of Engineering Technology degree or its equivalent from an (ABET) accredited college or university, with a 2.75 cumulative average or better (C = 2.0), may be eligible to complete one of the specified Bachelor of Science in Engineering programs by taking a *minimum* of 40 quarter hours (10 courses) of work. The courses to be taken are assigned by a departmental adviser and are based whenever possible on the student's previous background. Students who have a Bachelor of Engineering Technology, Bachelor of Science in Engineering Technology, or a Bachelor of Science in Engineering degree that is not professionally accredited may be required to take significantly more courses.

All Other Transfers to the College of Engineering

Students with previous academic experience not covered in the above categories will be placed at an appropriate point in the program they select, based on a course-for-equivalent-course credit evaluation.

Questions concerning these programs may be referred to the Department of Admissions (437-2213), or to the Office of the Dean of the College of Engineering (437-2152).

The Academic Year

Each academic year is composed of four quarters, beginning late in September and ending early in September. Full details with regard to registration are mailed approximately one month in advance. The programs are offered only at the Boston Campus.

Schedule of Classes

Class will normally meet two evenings each week, and occasionally on Saturday morning. Laboratory classes meet during additional evenings.

admissions information

ADMISSION

The Student Body

The student body of Lincoln College is composed of recent high school graduates and mature men and women. Most students are employed in industry, with vocational experience ranging from very little for the recent secondary school graduate, to as much as 20 or 30 years for individuals seeking increased professional responsibility and status. Many technical career categories are represented—industrial, engineering, scientific, and allied-medical—demonstrating that, in our increasingly complex society, the key to personal advancement is education.

Northeastern University is authorized under Federal law to enroll nonimmigrant alien students.

Academic Background

A firm knowledge of the fundamentals of mathematics and science is the foundation upon which successful achievements in the more advanced technological courses are built.

Applicants to Lincoln College are, in many cases, mature adults who, although they have experience in industry or previous education, have been away from formal study for some time, and therefore have doubts concerning their study habits and their algebra, geometry, and science proficiency. Those who anticipate some difficulty in adjusting to the first-year course requirements are advised to give very serious consideration to enrolling in noncredit courses in introductory mathematics, introductory physics, and/or introductory chemistry. These courses are designed to develop adequate background for the basic courses in the degree programs.

Program Counseling

Career planning through self-analysis and professional counseling assists students in planning educational programs appropriate to their objectives. Entering students are encouraged to arrange for personal interviews with Lincoln College program counselors for assistance in planning their academic programs. Counselors are available by appointment at the Huntington Avenue Campus, Boston, and at the other Lincoln College campuses listed at the front of this catalog. Students are encouraged to present records of prior education whenever possible. The effectiveness of the counseling review is greatly enhanced by this information. The University, through its Counseling and Testing

Center and its Career Information Center, is also prepared to assist applicants whose educational and vocational goals are more complex or less firmly defined.

Application for Admission

Information concerning admission may be obtained either by writing to Lincoln College or by requesting it at the time of visiting the College. The application for admission should be completed in detail and submitted to Lincoln College, Northeastern University, Boston, Massachusetts 02115.

All inquiries relative to the day cooperative programs should be referred to the Day College Admissions Office, 150 Richards Hall. (See pages 81 and 87.)

Mathematics Placement Test

Applicants requesting admission to regular first-year mathematics are required to demonstrate proficiency in introductory or basic mathematics through the Lincoln College Mathematics Placement Test. Students who request enrollment in the noncredit Introductory Mathematics course are not required to take the test. The Mathematics Placement Test will be administered during the registration period for each term of instruction at the Huntington Avenue campus, Boston, and the Suburban Campus, Burlington. The Mathematics Placement Test will be administered on selected dates at the Lincoln College campuses listed at the front of this catalog. In addition, the test is administered during the summer months. Contact the Lincoln College Office, 408 Churchill Hall, at the Boston Campus (437-2500).

Students who demonstrate satisfactory proficiency in the test will be permitted to register for the first-year courses in the program of their choice. To enroll in Engineering Physics (11.617) the student may need to take Introductory Physics.

If need for a strengthening of mathematical background is indicated, the applicant will be assigned to the Introductory Mathematics course.

Students enrolling in Introductory Mathematics may fill out their schedule by enrolling in Introductory Physics, Introductory Chemistry, or Engineering Graphics.

In every case the student should carefully consider the combined work and study load and register for only those courses which contribute to the development of a firm knowledge of fundamentals and which enable the student to adjust to academic study requirements.

CLASSIFICATION OF STUDENTS

Applicants who have filed an application for admission and who are approved by the Lincoln College Academic Standing Committee are admitted as regular students in the program which they have indicated on the application.

Special Students

Students having specific course needs, who do not desire a degree, may register for the courses if they have the required prerequisites or their equivalent. These students will be enrolled as "special students."

Matriculation

Petition forms of admission to the status of a degree candidate are available at offices on all Lincoln College campuses (see page 45). There are two methods of matriculation:

A. Standard Method of Matriculation
   1. A student who has completed 16 quarter hours of credit in Lincoln College must file a matriculation petition to be recognized as a degree candidate.
   2. The student must have a high school diploma or its equivalent and must achieve a cumulative quality point average of 2.00 (an average of C) for all courses completed before filing the petition.

B. Optional Method of Matriculation by Transfer Students
   1. A student who has transferred 16 quarter hours of credit from another accredited institution may file for matriculation following one quarter in residence in Lincoln College.
   2. A student who has completed 16 quarter hours of combined credit transferred from another accredited institution and earned at Lincoln College may file for matriculation..

All students filing for matriculation must have a high school diploma or its equivalent.

The Committee on Academic Standing may require a student to take one or more aptitude tests or interest tests if his or her credentials or academic record fail to give evidence of probable academic success. In this case, the student will be notified in writing that arrangements for testing should be made with the University Counseling and Testing Center. A fee is charged for these tests.

TRANSFER STUDENTS AND ADVANCED STANDING CREDITS

Students transferring from community colleges, junior colleges, technical institutes, or other colleges and universities may transfer applicable credits toward the degree requirements of Lincoln College.

Students admitted with transfer or advanced standing credits from another institution must meet the requirements for admission as set forth under the regulations applicable to regular students. Advanced standing in Lincoln College may be obtained by (1) transfer of credits or (2) proficiency examination.

Transfer of Credits

Subject to the approval of the Academic Standing Committee, credits may be awarded for academic work completed in other approved schools, colleges, or universities if the following criteria are met: (a) the content of the course being submitted is equivalent to that of the corresponding course in Lincoln College; (b) the average grade achieved in the course submitted is "C" or higher; and (c) the remoteness of the time of study does not negate its use as a prerequisite for an advanced course.

Applicants desiring advanced standing credit by transfer should indicate so at the time of filing the application for admission. The applicant should request the Registrar of the institutions of previous attendance to mail an official transcript to the Lincoln College Office.

Proficiency Examinations

Applicants who do not meet all the criteria for the normal transfer of credits, but who are able to supply evidence of sufficient knowledge of a subject as a result of previous training or experience, may petition the Academic Standing Committee for the privilege of taking a Proficiency Examination. If satisfactory proficiency is indicated by the examination, advanced standing credits may be awarded.

Readmission

Former students who seek readmission to continue a program of study after having withdrawn from the College for a period of time may be required to repeat courses which are prerequisites to advanced work.

REGISTRATION

Registration for Courses

Completion of admission requirements does not constitute official registration for courses. All students must be properly registered before attending classes. Registrations are processed by the Registrar's Office during the official registration periods. Former students should ascertain completion of prerequisite courses before registration. Students may register for full-year sequences of courses during the official registration periods. They are urged to register as early as possible in order to obtain the desired class schedule.

Changes in Registration

Changes in program should be initiated before the opening day of classes during the official registration periods.

Official Registration Periods

Official registration periods are scheduled before the Fall, Winter, Spring, and Summer Quarters during the academic year. Students are urged to register as early as possible during these periods. Dates of registration periods for each quarter are listed in the 1982-1984 Academic Calendar (see page 7).

Courses in Other Departments of the University

Lincoln College students assigned to courses in other departments of the University are charged the tuition rates and other fees effective in the departments in which they are enrolled.

academic information

ACADEMIC OPERATIONS

Campuses and Extensions

All courses are offered at the Huntington Avenue campus, Boston, with some courses available at the Suburban Campus, Burlington; Framingham North High School, Framingham; Norwood Junior High School North; Weymouth High Schools; and the Abraham Lincoln School in Revere; and for Aeronautical Technology students at the Suburban Campus, Burlington.

The Quarter Calendar

Northeastern University operates on a quarter-system calendar. All courses are evaluated in terms of quarter-hour credit. A quarter-hour credit is equal to three-fourths of a semester-hour credit.

Class Sessions

Classes at Northeastern are scheduled in different modules. In assessing quarter-hour weight for courses, the following statement applies. One quarter hour of credit is equal to approximately fifty minutes of instruction per week, plus two hours of preparation.

Course Work

All the usual methods of instruction are employed—lectures, home assignments, class projects, laboratory work, irregularly scheduled quizzes, and formal examinations. In addition, mid-course examinations are scheduled in most courses and a final examination is required at the completion of all courses. Students are responsible for fulfilling all the requirements of a course. In the event of absence, students must make appropriate arrangements for makeup with the instructor. Students must follow the procedures outlined below for makeup of missed mid-term or final examinations.

Student Study Areas

The University Library is well equipped with technical literature. A detailed statement about its facilities and hours appears on page 27.

Attendance

Students absent from regularly scheduled sessions in any subject, for whatever reason, may seriously jeopardize their academic progress and status. Students are expected to be in attendance at all the sessions scheduled in their

courses. Excessive absence may be sufficient cause for the Registrar to remove the subject(s) from the student's schedule.

Withdrawal

Simply ceasing to attend classes or notifying the instructor does not constitute official withdrawal from a course. To withdraw officially, the student must notify the Registrar's Office or complete the appropriate withdrawal form.

The Registrar will withdraw a student from a course who:

1. Does not attend the first three classes at the beginning of the quarter;
2. Does not attend the first two classes at the beginning of a summer term.

Family Educational Rights and Privacy Act

In accordance with the Family Educational Rights and Privacy Act of 1974, Northeastern University permits its students to inspect their records whenever appropriate and to challenge specific parts of them when they feel it necessary to do so. Specific details of the law as it applies to Northeastern are printed in the *Student Handbook* and are distributed annually during registration periods.

It is the policy of Northeastern University to deal with the student in all academic and administrative matters. If parents require any information regarding the progress of their son or daughter, they may contact the Dean of Students Office.

MAKEUP EXAMINATIONS

Mid-course Examinations

A student absent from a regularly scheduled mid-course examination or quiz may request permission to take a makeup examination. This is a privilege which may be denied if abused by an excessive number of petitions or for other reasons.

Students applying for makeup examinations must request from the instructor permission to take the mid-term examination or quiz. The instructor will forward the examination to the Lincoln College Office for processing.

Makeup mid-term examinations and quizzes will be given on a Saturday at 9:00 a.m. in a designated room at the Huntington Avenue campus according to the published schedule. Contact the Lincoln College Office, 408 Churchill Hall (Telephone 437-2500).

Any student who does not take the makeup examination as scheduled will forfeit the makeup privilege.

Missed Final Examinations

A student absent from a final examination will receive a grade of "I" (Incomplete) in the course. He or she may petition for a makeup final examination at the Registrar's Office, 120 Hayden Hall.

A student does not automatically have the right to make up a missed final examination. Students must petition for this privilege. If the petition is granted, the student must pay a $10.00 fee for taking the special final examination. Petitions may be obtained from the Lincoln College Office or in each off-campus Administration Office. Petitions for missed finals must be filed in accordance with the published schedule. Contact the Lincoln College Office, 408 Churchill Hall (Telephone 437-2500).

Students will be notified by mail when and where to take the missed final examination. All examinations will be administered on the Boston campus. Those who do not take makeup final examinations as scheduled forfeit the makeup privilege.

ACADEMIC STANDARDS

The student is required to maintain appropriate levels of academic achievement in terms of grades, quality-point average, and the quantitative credit requirements of his or her program of study to satisfy academic progress criteria and achieve graduation from Lincoln College.

Grading System

The following system of grading is used. The numerical equivalent for each grade is in parentheses.

A	(4.000)–	Outstanding Attainment
A–	(3.667)–	
B+	(3.333)–	
B	(3.000)–	Good Attainment
B–	(2.667)–	
C+	(2.333)–	
C	(2.000)–	Satisfactory Attainment
C–	(1.667)–	
D+	(1.333)–	
D	(1.000)–	Poor Attainment
D–	(0.667)–	
F	(0.000)–	Failure
I	— –	Incomplete
L	— –	Audit (No Credit)
S	— –	Satisfactory achievement in a pass-fail course; counts toward total degree requirements
U	— –	Unsatisfactory achievement in a pass-fail course
X	— –	Incomplete in a pass-fail course
*	— –	Grade not received

A general average of "D" is unacceptable and will not allow a student to continue in Lincoln College or to receive a degree from Northeastern University. The "F" grade is a definite failure. The standard procedure for clearing failures

in courses offered in Lincoln College is to repeat the course. In some instances circumstances may warrant amending the standard procedure. These circumstances are described in the *Student Handbook* for day students. An "I" or "X" (incomplete) grade is used for a temporary grade to show that the student has not completed the course requirements.

Pass-Fail Courses

Any student who is not on academic probation and who has completed 40 quarter hours of academic work may register for one pass-fail course and, thereafter, for one course on a pass-fail basis for each 10 quarter hours of successfully completed work. Written permission of the appropriate academic dean must be obtained for each pass-fail course. At no time may a student register for more than one pass-fail course per quarter.

Such courses will be restricted to free electives outside the major field of specialization, so that no part of the specifically prescribed curricula will be affected.

The grades recorded on the basis of the pass-fail system of grading will not figure in the computation of the Q.P.A.

Auditing Policy

Students are permitted to audit courses upon filing the usual registration forms and paying the regular tuition fees. There is no reduction in fees for auditing. An auditor may participate in class discussion, complete papers and projects, and take tests and examinations for informal evaluation if desired. However, regardless of the amount or quality of work completed, **no academic credit will be granted at any time for courses audited.**

Audit Procedure

The student's decision to take a course on an audit basis must be communicated in writing to the Registrar prior to the fourth class meeting of the course. No exception to this procedure can be approved without authorization by the Academic Standing Committee of the College.

Grade Reports

Grades are mailed to the student by the Registrar and will not be given out at the office of either the Registrar or Lincoln College. Under no circumstances will grades be given over the telephone.

Quality-Point Average

The quality points earned by the student in a given course are determined on the basis of the letter grade achieved and the number of credit hours carried by the course. The total quality points earned, divided by the total number of credit hours, constitutes the quality-point average.

1. When the student has more than one grade in the same course, the most recent grade will be used in the calculation of the quality-point average.
2. A grade of "I" will not be considered in the calculation of the final quality-point average.
3. Although advanced standing credits (ASC) allowed for acceptable work completed at other institutions by transfer students count toward completion of the quantitative credit requirements, neither the credits nor the grades earned in such courses are included in quality-point average computations.
4. In programs made up of combined University College and Lincoln College courses, the cumulative quality-point average will include all work in both colleges.

For example, a student who has registered for 13 courses, cleared a failure in one of them, cleared an incomplete in another by repeating the course, and received advanced standing credit (ASC) in another, may calculate the quality-point average as follows:

Grade Achieved	Numerical Equivalent		Credit Hours		Quality Points
A	4.000	X	4	=	16.000
A–	3.667	X	3	=	11.001
B+	3.333	X	3	=	9.999
B	3.000	X	4	=	12.000
B–	2.667	X	2	=	5.334
C+	2.333	X	2	=	4.666
C	2.000	X	4	=	8.000
C–	1.667	X	3	=	5.001
D+	1.333	X	2	=	2.666
D	1.000	X	3	=	3.000
D–	0.667	X	2	=	1.334
F	0.000	X	2	=	0.000
FB	3.000	X	3	=	9.000
I	—	X	–	=	—
IC	2.000	X	2	=	4.000
ASC	—	X	–	=	—
		TOTALS	39		92.001

$$\text{Quality-Point Average} = \frac{\text{Total Quality Points (92.001)}}{\text{Total Credit Hours (39)}} = 2.359$$

The Registrar's Office will not be able to recalculate or confirm the calculations of quality-point averages for individual students. Each student's record will be brought up to date before graduation. In the meantime, borderline cases will be checked by the Lincoln College Academic Standing Committee.

Academic Progress Criteria

It is expected that the student will at all times endeavor to achieve a high record of achievement. The Academic Standing Committee reserves the right to review all students' records and deny readmission to those who fall below a minimum quality level of achievement. This requirement has been established as follows:

In order to be allowed to remain in the College, a student must have achieved a quality-point average of 1.4 at the completion of 24 quarter hours; 1.5 at the end of 48 quarter hours; and 1.6 at the end of 72 quarter hours.

It should be further noted that a student who accumulates the equivalent of six uncleared failures may be considered ineligible to continue the program of study.

Scholastic Probation

The Academic Standing Committee has the authority to dismiss from the College or place on scholastic probation any student whose scholarship is deficient for the following reasons: low quality-point average or excessive outstanding failures regardless of quality-point average.

A student on scholastic probation should be particularly diligent in current course work and make every effort to clear the academic deficiencies as soon as possible. Students whose academic records do not improve or whose failures are not properly cleared may not be allowed to register for further courses.

A student on scholastic probation who has cleared all or a substantial part of any outstanding failures may petition the Academic Standing Committee for removal from the probation list.

Disciplinary Probation

The Academic Standing Committee has the authority to dismiss from the College or place on disciplinary probation any student whom it may deem unworthy because of conduct or character. The Committee may ask any student to withdraw from the College who is obviously out of sympathy with its aims and ideals.

GRADUATION REQUIREMENTS

To receive the degree of Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology, the student must fulfill the following requirements:

1. Been formally accepted into "degree candidate" status by the Committee on Admissions;
2. Complete all the courses of the particular curriculum, either by attendance at Lincoln College or by receiving Advanced Standing Credit;
3. Complete Associate degree programs in eight years and Bachelor's programs in 12 years from the date of entrance into Lincoln College. Extensions of time may be granted by the Academic Standing Committee;

4. Be in attendance for at least a year preceding the expected graduation date; and complete at least one-fourth of the work in Lincoln College;
5. Achieve a quality-point average of at least 1.800 in courses taken in the College to be awarded the Associate in Engineering or Associate in Science degree. Achieve a quality-point average of at least 2.000 in all courses in their respective major and at least a 1.800 quality-point average overall for the Bachelor or Engineering Technology degree;
6. Pay the graduation fee of $25.00.

In addition, students:

7. May not earn two Associate degrees or two Bachelor's degrees in the same field of academic specialization;
8. Must complete a minimum of 30 quarter hours of additional credits to be awarded more than one Associate or Bachelor's degree;
9. May not be awarded the Associate and Bachelor's degrees at the same commencement;
10. Must petition for transfer of credits completed at other institutions prior to January 1 of the year in which the degree is to be awarded.

ACADEMIC AND PROFESSIONAL AWARDS

The academic programs offered by Lincoln College and the teaching, counseling, and professional efforts of the faculty and staff are aimed at motivating the student toward the highest possible levels of academic achievement. To encourage scholarly and professional excellence and to recognize quality achievements, the following awards are made at appropriate times during the academic year:

Honor List and Dean's List Scholars

Students maintaining honor grade averages—minimum quality average of 3.000 and no "D" grades—during a quarter while carrying a minimum of 6 quarter hours credit are recognized as Dean's List Scholars. Students desiring certificates attesting to this honor should request them from the Lincoln College Office.

Scholastic Achievement Certificates

Upon graduation with an Associate degree, Scholastic Achievement Certificates will be awarded to those students who have achieved distinctly superior attainment in the academic work as follows:

Scholastic Achievement	3.000-3.499 Q.P.A.
High Scholastic Achievement	3.500-3.749 Q.P.A.
Highest Scholastic Achievement	3.750-4.000 Q.P.A.

In order to be eligible for a Scholastic Achievement Certificate, the student must earn a minimum of 48 quarter hours of credit in Lincoln College.

Graduation with Honor

Upon graduation, honors will be conferred upon students who have achieved distinctly superior academic achievement in a program leading to the Baccalaureate degree as follows:

Honor	3.000-3.499 Q.P.A.
High Honor	3.500-3.749 Q.P.A.
Highest Honor	3.750-4.000 Q.P.A.

In order to be eligible for Honors, the student must earn a minimum of 72 quarter hours credit in Lincoln College and receive a vote of approval from the faculty with responsibility for the program.

University Awards

The University Awards are presented annually to seniors who have achieved high ranking cumulative academic records. Certificates are awarded at the Annual Class Day ceremony.

Technology Awards

The Technology Awards are presented annually to seniors who have demonstrated superior academic and professional capabilities in their special career fields. Appropriate certificates are distributed to outstanding students enrolled in the following program categories:

Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology
Computer Technology

Class Marshal Award

The Class Marshal Award is presented annually at the Class Day Banquet for Graduates to the top ranking senior in a baccalaureate program. The award consists of an appropriate certificate and the President's Letter of Commendation.

Sigma Epsilon Rho Awards

Sigma Epsilon Rho, the evening colleges' scholastic honor fraternity, annually awards plaques and scholarships for outstanding scholastic achievement to the highest ranking students in University and Lincoln Colleges at the end of their junior year.

Sigma Epsilon Rho Honor Society Scholarship Award

The Sigma Epsilon Rho Honor Society Scholarship Award, established in 1974 by the membership of the Society, is awarded annually to a student of University and/or Lincoln College. Eligible students must have a cumulative

quality point average of 3.0 or better after completing 80 percent or more of their required studies.

Alumni Award for Professional Promise

Established in 1947 by the Northeastern University Alumni Association, the Alumni Award for Professional Promise is presented annually at a final senior class meeting in the spring of the year. The award is made to the senior who has demonstrated unusual professional promise through character traits, scholastic achievement, and work performance.

Leslie B. Cutler Aviation Awards

The Leslie B. Cutler Aviation Awards were established by the members of the Aero Club of New England to honor and give recognition to the late Senator Cutler's service and devotion to the interests of aviation in the Massachusetts General Court, national legislative bodies, and her private life. These scholarship awards are made to students in the Commercial Aeronautical Technology Program who most typify the same interest, devotion, and leadership demonstrated by Senator Cutler during her long and distinguished public career.

Mark Caldwell Whitney Memorial Aviation Scholarship Fund

This Fund was established in 1981 by the family and friends of the late Mark Caldwell Whitney, an outstanding 1973 graduate of the Aeronautical Technology Program. Income from the Fund will be awarded annually to a student with financial need who exemplifies Mr. Whitney's love of flying and commitment to excellence in the aviation field.

financial information

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time.

TUITION

Initial Registration Fee

A nonrefundable $10.00 registration fee, required of all new students, is due and payable upon registration.

Tuition

Tuition for all part-time evening courses offered for 1982–1983 is $75.00 per quarter hour of credit. Tuition for Day B.E.T. students will be based on the current day school rate. Charges for registration and tuition for special courses are at the rate specified for each course. Students are permitted to audit courses; however, there is no reduction in fees for auditing.

Students are not permitted to attend class sessions or take any examination or test until they have paid their tuition fees or have made satisfactory arrangements for payment.

Students will not be advanced in class standing, nor permitted to reenroll in the University, nor have degrees conferred, until all financial obligations to the University have been met.

No certificate of honorable dismissal will be issued to any student who has not fully met his or her financial obligations to the University.

Noncredit courses are charged at quarter-hour rates equal to those of credit courses meeting on an equivalent contact-hour schedule.

Courses in Other Departments of the University

Students assigned to courses in other departments or colleges of the University are charged the tuition rates and other fees effective in the departments in which they are enrolled.

Aeronautical Technology Tuition (Day Program)

The amount of flight instruction required by each aeronautical technology student is not fixed. Since each student progresses at his or her own pace, exact tuition quotes cannot be made for the complete program. Students will be free to negotiate the flight tuition with the several flight schools approved by the University.

Day Program Tuition Deposit

Applicants accepted for admission to the day program must upon request pay a nonreturnable tuition deposit of $100 as evidence of their intention to enroll; this will be applied to their first tuition payment.

Tuition for all courses is charged on a quarter basis and is payable in full at the beginning of each quarter.

Deferred-Payment Privilege

Occasionally situations develop, usually beyond the control of the student, which make it difficult to meet payments in the regular manner. Under such circumstances, the student is advised to discuss the problem personally with the Bursar's Office, where a convenient deferred-payment agreement can be worked out. A service fee of $5.00 is charged for this privilege.

Late Payment Fee

Payments of tuition are due by Saturday of the week in which the bill is dated. If payment, or a deferred-payment agreement, is not arranged by that date, a late fee of $50 is charged by the Bursar.

Refund of Tuition

The general policy in all schools and colleges of the University with respect to refunds of tuition to students is as follows:

The University provides all instruction on an academic quarter basis for which students pay at the beginning of each quarter. Tuition refunds will be granted through the first four weeks of a quarter only when specified conditions are met. Questions regarding refunds should be discussed with the Bursar.

Tuition refunds will be granted only on the basis of the date appearing on the official withdrawal application when filed with the Registrar in Room 120 Hayden Hall. Nonattendance does not constitute official withdrawal.

Refunds will be granted in accordance with the following schedule:

Official withdrawal filed within:	Percentage of tuition
1st week of quarter	100%
2nd week of quarter	75%
3rd week of quarter	50%
4th week of quarter	25%

Tuition Underwritten by Employers

An increasing number of companies are underwriting part or all of the cost of tuition of students in their employ. In cases in which payment is made directly by the employer to the University, the student should furnish the Bursar's Office a purchase order covering the registration or a statement from an officer of his or her company certifying that the company is underwriting the tuition.

Student Bursar

All inquiries about student accounts should be directed to the Student Account Bursar, 437-2270.

Veterans' Benefits

Veterans' benefits depend on course load and increase sharply when a student's program exceeds eight quarter hours per quarter. Questions and applications should be directed to Room 116 Hayden Hall, Telephone 437-2283.

SPECIAL FEES

International Student Fee

New undergraduate international students are charged a $200 fee, payable, one time only, upon admission to the University.

Student Center Fee

Students attending the Huntington Avenue campus, Boston, in the evening in a part-time program of study will be assessed a Student Center Fee of 75¢ per quarter.

Health Service Fee

Students attending the Boston, full-time Day cooperative B.E.T. programs are required to pay a Health Service Fee of $220. The program is available to Aeronautical Technology students on an optional basis.

Missed Final Examination Fee

Students absent from the regularly scheduled final examination at the end of a course may petition for a "special final examination." The fee for each examination requested by the student is $10.00. The fee must be paid when the petition is filed in the Lincoln College Office.

Proficiency Examination Fee

Applicants for admission may petition to be awarded advanced standing on the basis of achievement demonstrated by a "proficiency examination." The fee for each examination requested by the applicant is $25.00. The fee must be paid when the petition is filed in the Lincoln College Office.

Graduation Fee

The University graduation fee, charged to candidates for the Associate or Bachelor's degree, is $25.00, payable on or before May 1 of the year in which the student expects to graduate.

Transcript of Record Fee

Students may request transcripts of their records at the University Registrar's Office. There is no charge for the first transcript. After the initial transcript there is a charge of $2.00 per copy, payable in advance.

TEXTBOOKS AND SUPPLIES

Students purchase their own textbooks and work materials. The cost varies according to the subject for which the student is enrolled. The average cost for a normal program of four subjects generally ranges from $50.00 to $100.00. Textbooks for single courses range from $10.00 to $40.00.

Students enrolled in Engineering Graphics should be prepared to spend $25.00 to $35.00 for drawing supplies and $15.00 to $25.00 for a set of drawing instruments in addition to the textbooks.

LOAN PROGRAMS

Full-time students in Lincoln College who are pursuing the B.E.T. Program should refer to the Undergraduate Catalog for financial aid information.

FINANCIAL AID

The Office of Financial Aid, located in 254 Richards Hall, offers several types of assistance to part-time students. All awards are based on financial need. Aid granted from programs sponsored by the Federal government is dependent upon the amount of funding allocated to Northeastern University.

Basic Educational Opportunity Grants (BEOG)

The Basic Educational Opportunity Grant program is a Federal aid program designed to provide financial assistance to those who need it to attend post-high school educational institutions. Basic Grants are intended to be the "floor" of a financial aid package and may be combined with other forms of aid in order to meet the full costs of education. BEOG is a grant and, unlike a loan, does not have to be repaid. Half-time students taking at least 6 credit hours each quarter may apply. Awards range up to one-half the maximum allowable by law, contingent upon the total cost of education. Applications are available in the Office of Financial Aid, 254 Richards Hall, or by writing to BEOG, Post Office Box 84, Washington, D.C. 20044.

National Direct Student Loan

This program is available to students who are carrying at least one-half the normal academic workload, are accepted as degree candidates, i.e., have 16 credit hours and a matriculation certificate, and who show evidence of financial need.

Direct Loans are available to students who present evidence of needing financial assistance. Undergraduate students may borrow up to a maximum of

$3,000 for the first two years, or a total of $6,000 for their entire undergraduate education. Students are allowed a total maximum of $12,000 through their undergraduate and graduate education. Repayment and interest on Direct Loans are not required until six months after a student graduates or withdraws from the institution. Repayment of principal may be extended over a 10-year period, with the interest rate of 5% per annum. Repayment may be deferred up to a total of three years if the student is pursuing at least a half-time course of study or serving in the Peace Corps, VISTA, or the armed forces.

Community Sources

Students and their families are urged to explore community, industrial, and foundation sources for collegiate financial aid. Parental employers or the appropriate union organization may be a source. In addition, local, civic, political, religious, or educational leaders are often aware of aid sources in the immediate community. Some typical sources may include: P.T.A., Kiwanis, Lions, Elks, Knights of Columbus, Masons, Sons of Italy, Rotary, State Rehabilitation, American Legion, and similar groups or organizations.

University Grants

Each year Northeastern University grants a substantial number of full and partial tuition grants to students who have demonstrated both above-average scholastic achievement and financial need. All applications for aid are automatically considered for all grants administered by the University. It is not necessary for an applicant to specify the grant in which he or she is interested.

Veterans' Benefits

Any veteran covered by the Veterans Readjustment Act of 1966, Public Law 89-358, should report to Room 116 Hayden Hall to fill out the proper enrollment forms. These forms will be made available during registration periods for all students in the Law Enforcement programs at special off-campus locations.

Students needing additional information as to eligibility, allowances, or other details are urged to contact their local office of the Veterans Administration as early as possible.

Guaranteed Student Loan Program

Under this program, students who are matriculated degree candidates, enrolled for at least one-half the normal academic work load, may borrow from a participating bank or other financial institution. Terms and conditions vary from state to state, but a student generally may borrow up to $2,000 a year (the law allows a maximum of $2,500 per year) depending on financial need. The Federal government pays the interest while the student is in school if the student is eligible for interest subsidy.

Applications for this loan are available from local banks or the Education Office of your state government. Additional information is available from the Financial Aid Office.

Martin Luther King, Jr. Scholarships

These scholarships were established in 1969 in memory of the late Rev. Martin Luther King, Jr. Awards are made as openings occur to adults from minority groups who would otherwise be unable to continue their education. Stipends will cover tuition expenses not to exceed 6 quarter hours in any academic quarter (excluding the Summer Quarter).

H. Patricia Taylor Scholarship Fund

The H. Patricia Taylor Scholarship Fund was established in 1974 by H. Patricia Taylor, a graduate of University College, and her husband, Harry C. Taylor, a graduate of the School of Business. The Scholarship expresses their appreciation for financial assistance made available to Mrs. Taylor while obtaining her degree, and is an attempt to provide similar funds to assist others in realizing their potential through higher education. The income from the Scholarship Fund will be awarded annually to a student enrolled in University College or Lincoln College who demonstrates financial need and academic stability and who meets certain other conditions of eligibility.

Robert G. Keene Memorial Scholarship Fund

This Fund was established in 1979 in memory of Robert G. Keene, a graduate of Lincoln College, Class of 1972. The endowment funds were provided by the friends and associates of Robert G. Keene and the Polaroid Corporation, where he served as an Engineering Manager. The income from the Fund will be awarded annually to an undergraduate student in any College of the University who demonstrates financial need as well as strong character and initiative. Primary consideration will be given to children of Polaroid employees.

student activities and alumni information

Evening Student Council

The Evening Student Council (E.S.C.) was formed to provide a representative body to promote the welfare of the student body in nonacademic areas and to foster extracurricular activities which will enrich University life. It affords participants opportunities to meet and develop close personal relationships with fellow students and administrative staff.

The Evening Student Council provides students with opportunities to develop leadership skills and gives them a chance to discuss matters of professional interest with experts in their chosen field.

The Council is made up of interested students in University and Lincoln Colleges, representatives of part-time interest groups, and those specially certified by the Council because of their demonstrated interest in the overall adult programs of the University.

The E.S.C., a member of the United States Association of Evening Student Councils, meets evenings on a monthly basis. Students are welcome to visit, observe, and express opinions concerning evening student life.

Social and Professional Clubs

Student activities for part-time students are planned, organized, and operated by the student body with the assistance of the Director of University-Lincoln College Student Activities. The programs are designed to keep pace with the changing needs of adult students and to provide maximum opportunity for student participation. All part-time students in University College and Lincoln College are welcome to participate.

The program is flexible in nature and pioneering in spirit to meet the needs of adult students. The Office of University-Lincoln College Student Activities is particularly interested in developing new clubs which will benefit students professionally and educationally. If students wish to start clubs related to their professions, this office will help them plan and organize on the local and national levels. The program is dedicated to assisting the adult student in the development of his or her fullest potential. The University-Lincoln College Student Activities Office is located in 102 Churchill Hall.

Use of Gymnasium Facilities

Specific schedules for use of the pool, weight training room, indoor athletic field and track, gymnasium, and wrestling room are set up each quarter for use by all part-time students. In order to become eligible, students must obtain a temporary gymnasium pass each time they wish to use the Cabot Gymnasium

complex. Passes are available in Cabot, Room 111, Monday through Friday from 4:30 p.m. to 9:30 p.m., and on Saturday and Sunday during all open hours. All students requesting a pass must present their Student Identification Card. Students using the Cabot Gymnasium complex are required to abide by all the rules of the gym and may be asked to complete a Medical Release Form. Revised schedules for holiday periods will be posted.

Alpha Eta Rho

The Nu Epsilon Chapter of this international aviation fraternity is a social organization open to all Aeronautical Technology students. It is organized to actively associate the interested students of aviation with leaders and executives in the industry. This close association, strengthened through the bonds of an international aviation fraternity, establishes opportunities for members in their relation to aviation and inspires interest and cooperation among those in the profession who are also members of Alpha Eta Rho.

Alumni Association

More than 86,000 alumni are members of the all-University Alumni Association, which has as its prime purposes the promotion of the welfare of Northeastern University, the establishment of a mutually beneficial relationship between the University and its alumni, and the perpetuation of fellowship among members of the Association.

The Association headquarters are located in 310 Churchill Hall. The official records and addresses of alumni are maintained at 236 Huntington Avenue.

Activities of the Association, including the Homecoming Day celebration and the annual presentation of Professional Promise Awards to outstanding seniors in each of the colleges, are directed by the Vice President for Alumni Affairs. Alumni officers also attend meetings of undergraduate classes to form a closer relationship between the Association and its future members.

The Alumni Relations Office assists the various class officers in planning class reunions. Each class normally holds a reunion every five years during the month of June. The Vice President for the Alumni Class Council is responsible for coordinating class activities and organizing class functions.

The Vice President for Alumni Clubs works in close association with officers of the more than 50 Regional Alumni Clubs which have been established from coast to coast. All alumni are eligible to become members of these organizations. The alumni clubs meet periodically, often in conjunction with visits from members of the faculty or with athletic events.

For Boston area alumni, monthly luncheon meetings are held in both the downtown and uptown sections of the city.

The Association also sponsors and assists the alumnae organization and the Varsity Club, both of which have their own officers and conduct various programs throughout the year. Through the Varsity Club, the Association presents trophies to the outstanding athlete of the year in each of the six major sports.

One of the most recent developments in alumni activities is the organization of seminars, which are conducted by the Association in cooperation with the University's Center for Continuing Education. The seminars are designed particularly for alumni who have a special interest in current events and the field of adult education.

The Northeastern University Alumni Association is a member of the American Alumni Council, a professional organization composed of representatives of all major colleges and universities in the United States and Canada.

Alumni Relations

The Alumni Association is providing a uniquely valuable service to both the University and the community by sponsoring admissions conferences for parents of high school students who are interested in attending college. These meetings, held in cooperation with the Northeastern Department of Admissions, have been extremely well attended. Local residents as well as alumni of the University have been invited to these conferences, which help to clarify many of the questions today's parents and young people have concerning application procedures of colleges and universities.

Placement Service

Many requests from employers are received by the College for men and women of potential ability to fill important positions of responsibility. It is the policy of the College to serve the students whenever possible by placing them in those positions which promise attractive opportunities for development and advancement. The College cannot guarantee to place its students, but it does endeavor to keep in close touch with those who desire placement service and to assist them in obtaining satisfactory advancement in position and income. No charge is made for placement service. Those needing this assistance should arrange an appointment with the Director of Placement.

While the College cannot guarantee positions to its graduates, the number of requests usually exceeds the number available in the graduating class of any given year. The policy of the College is to find the best qualified men and women among its graduates for the positions which the College is called upon to fill.

The College, in recommending a graduate for a position, furnishes the prospective employer with the facts as to the graduate's ability, character, attitudes, habits, and other qualifications for the position as revealed by the College records. In the last analysis, however, placement in a position depends largely upon the graduate's ability to sell his or her services to the prospective employer. Most employers prefer to consider two or more candidates for a position and generally ask the College to suggest more than one person. Many manufacturing and commercial firms throughout New England call upon the College to assist them in filling important executive and managerial positions.

academic programs of instruction

SCOPE OF PROGRAMMING

Lincoln College, either by itself or in collaboration with University College, conducts educational programs at the undergraduate level in the following areas of technology:

Pre-Technology Preparation
Aeronautical Technology
Civil Engineering Technology
Electrical Engineering Technology
Mechanical Engineering Technology
Computer Technology

Program Selection

Students should be sure that the program they desire is offered in a suitable time period. Most programs are offered in the evening on a part-time basis. However, Aeronautical Technology is offered only on a full-time day basis.

In the fields of Electrical Engineering Technology and Mechanical Engineering Technology, full-time day cooperative programs were established in the fall of 1971. Students may enter as freshmen or transfer with advanced standing by applying to the Office of Admissions, Northeastern University, 150 Richards Hall.

Degrees and Certificates

Lincoln College conducts education programs on the undergraduate level in various technological areas leading to the following degrees and certificates:

1. Associate in Science degree (A.S.) requiring 96 to 105 quarter hours of credit;
2. Associate in Engineering degree (A.E.) requiring 96 to 103 quarter hours of credit;
3. Bachelor of Engineering Technology degree (B.E.T.) requiring 180 to 183 quarter hours of credit.

Most courses are available for special students.

Opportunities for Associate Degree Graduates

Graduates of the Engineering or Science Technology Programs in Lincoln College, or other similar colleges and institutions, who have earned the Associate in Engineering or the Associate in Science degree, may transfer ap-

plicable credits toward the degree requirements in the baccalaureate programs in Engineering Technology, Medical Technology, or Industrial Technology.

Those who have maintained a quality-point average of 2.75 or higher in the Associate degree programs may apply for transfer to either of the following College of Engineering curricula: (1) day college cooperative education programs in Civil, Mechanical, Electrical, or Industrial Engineering with credit for up to two years of the five-year program; or (2) the part-time evening programs in Civil, Electrical, or Mechanical Engineering with credit for the first three years of the eight-year programs.

PRE-TECHNOLOGY PREPARATION

(Noncredit)

Beginning students who have been away from formal study for some time are frequently concerned about their study habits and their verbal, mathematical, and scientific backgrounds. Applicants who anticipate some problems should give serious consideration to enrolling in the noncredit introductory courses, the Reading Improvement Program, or doing review work through programmed instruction at the Learning Center.

Introductory Courses

These courses offer the student the opportunity to develop background for basic courses in the degree programs and thus increase the probability of successful achievement in advanced technology courses.

Introductory Mathematics I and II

A two-quarter review of high school algebra and some plane geometry designed to prepare students for the course 10.607 College Algebra and Trigonometry I. These courses are required of students who do not demonstrate sufficient algebra proficiency on the Mathematics Placement Test. (See course descriptions for 10.681 and 10.682, page 125.)

Introductory Physics I and II

A two-quarter, relatively nonmathematical introduction to the concepts of physics designed to allow students to prepare themselves for the courses 11.617 Physics I or 11.604 General Physics I. (See course descriptions for 11.681 and 11.682, page 127.)

Basic Mathematics I and II

A two-quarter review of basic algebra offers students the opportunity to prepare themselves for the course 10.627 Mathematics I. These courses are required of students who do not demonstrate sufficient proficiency in algebra on the Mathematics Placement Test. (See course descriptions for 10.671 and 10.672, page 125.)

English for International Students I, II, III

A three-quarter, noncredit sequence for foreign-speaking students covering introduction to English grammar, with emphasis on listening, speaking, and writing; selected readings and exercises to strengthen vocabulary and pronunciation; preparation of written and oral reports, business and social correspondence; and advanced work in written and spoken English preparatory to entering 30.305 English I.

Reading Improvement

The ability to read well is one of the most important basic tools for the successful completion of a college program. The University's Center for Reading Improvement gives the student an opportunity to develop good reading habits in preparation for the intensive reading assignments of college-level courses. The following core skills are covered: previewing, locating main ideas and related details, using guide words and phrases, identifying structural patterns, outlining and summarizing, note-taking, vocabulary building, skimming and scanning, speed-reading, and critical reading. Further information may be obtained at the Center for Reading Improvement.

Programmed Study

Students may enroll in noncredit, self-study courses to better prepare themselves for college academic work and strengthen their high school background at the University's Learning Center, 406 Dodge, Tel. 437-2465.

Courses which may be useful to students in the Lincoln College programs in technology are: slide rule, trigonometry, effective listening, spelling, algebra, study skills, calculus, and English.

University Learning Center hours:
Monday, Tuesday, Wednesday, Thursday—8:00 a.m.-8:00 p.m.
(Thursday—closed 12:50 p.m.-1:50 p.m.)
Friday—8:00 a.m.-7:00 p.m.
Saturday, Sunday—1:00 p.m.-5:00 p.m.

AERONAUTICAL TECHNOLOGY PROGRAM

The Aeronautical Technology Program offered by Lincoln College through its Federal Aviation Administration Approved Pilot Ground School offers exposure to the scientific, technological, and business backgrounds required by the modern commercial pilot or entrepreneur in today's aviation and aerospace world as it operates within the framework of the total ship-rail-motor-aircraft transportation industry.

The tremendous expansion of aviation as an increasingly important sector of the nation's industrial economy has accelerated the demand for appropriately trained and educated personnel for careers related to the flight, instructional, regulatory, management, and technical aspects of the aviation industry.

Flight opportunities range from pilot or co-pilot in the single- or multi-engine air-taxi and cargo services of the feeder airlines or private company to flight engineer, first officer, or captain in the high-speed, multi-jet-engined services of the national and international systems of the major airlines.

The education-training-regulation sector of the aviation industry provides additional career opportunities as flight, ground, or simulator instructors or as flight examiners, training or safety directors, and supervisors in the licensing and regulatory agencies of local, state, or Federal government.

Persons knowledgeable in the technology and regulations of aviation, who are also skillful in dealing with people, may pursue challenging and rewarding careers in aviation sales, airport operations, aviation business management, or related areas.

The Aeronautical Technology-related program, presently offered by Lincoln College, is a two-year full-time day program which leads to an Associate in Science degree.

This program is conducted at the Suburban Campus in Burlington, Massachusetts, and local air fields. Aeronautical students at Northeastern University need their own transportation, since there are no dormitories on this campus.

Aeronautical Technology — Major Code 096

Leading to the Degree of Associate in Science
(Day Program—2 Years)

The curriculum of the Aeronautical Technology program offers students the opportunity to prepare themselves in the shortest reasonable time to assimilate the required amount of related academic instruction and accumulated flight time for certification with the Private and Commercial Instrument Ratings by the Federal Aviation Administration.

Prerequisites: An applicant for admission to the Aeronautical program should have completed a minimum of algebra I and II and geometry. The student must have a high school diploma or its equivalent. The flight student will be required to obtain the F.A.A. Class I or II medical certificate. All candidates for admission must have an interview with the Aeronautical program counselor.

Fall	Winter	Spring	**First Year**	
Course Number				Q.H.
10.607	10.608		College Algebra & Trigonometry I, II	8
		10.620*	Calculus I	4
11.617	11.618	11.619	Physics I, II, III	12
30.305	30.306		English I, II	6
		93.401	Technical Communications	4
96.404			Fundamentals of Aeronautics	4
	96.437		Advanced Aeronautics	4
		96.444	Meteorology & Climatology	4

*Optional

Second Year

96.308			Aircraft Power Plants & Systems	4
	96.324	96.325	Introductory Avionics, Avionics	8
96.418			Intermodal Transportation	4
	48.314		Air Transportation	3
		96.420	Airline Traffic & Sales	4
96.417			General Aviation Operations	4
	41.301	41.302	Accounting Principles I, II	6
96.438			Instrument Procedures	4
	96.410		Aviation History I	4
		( )	Aeronautical Elective	4

Professional Pilot Program (Flight)

96.334			Private Flight Lab.	4
	96.439		Advanced Flight Lab.	4
		96.339	Instrument Flight Lab.	4
			Total A.S. Degree	103

With the approval of their adviser, students following the professional pilot track will satisfy the program flight training requirements at Northeastern University recommended flight schools. These students will be required to make individual arrangements for their flight training and will be awarded credit based on the successful completion of the rating being sought.

Second Year (Non-Flight Option)

Students electing the Non-Flight Option will replace the commercial flight courses with a sequence of air transportation, law enforcement, engineering, or airport management courses. These courses are listed under the description of courses at the end of the catalog.

Students having definite plans to enter other upperclass programs following the completion of the Associate degree should consult their adviser regarding entrance requirements prior to registering for second-year courses.

Students completing the Associate and Bachelor's programs may acquire the scientific, technological, and business background for employment in a variety of positions, including: Flight Crew Officers, Airport Management, Fixed Base Operations, Air Transportation, Aviation Sales, F.A.A. positions, and others.

Notwithstanding any of the other Aeronautical program requirements, each student must satisfactorily complete 96 quarter hours of course work to be eligible for the Associate degree.

Certificate of Advanced Study in Aeronautical Technology

The Certificate of Advanced Study in Aeronautical Technology will be awarded to students who satisfactorily complete 48 quarter hours of course work beyond the Associate degree.

Course programs will be arranged to enhance the student's individual career objectives and will consist of advanced aeronautical courses, engineering technology, or science courses.

Prerequisite: Associate degree in Aeronautical Engineering or equivalent.

CIVIL ENGINEERING TECHNOLOGY PROGRAMS

Civil Engineering deals with the planning and construction of all kinds of relatively permanent structures and public works. Its major functions are: the preparation of surveys (topographical, geological, traffic, utility, etc.); the design of structures (buildings, bridges, dams, harbor facilities, etc.); the planning of municipal systems (water, sanitary, gas, flood control, air pollution control, etc.); and the development of transportation facilities (highway, railway, waterway, airway, etc.).

In performing these functions, the civil engineer usually works in close association with professionals in the field and may develop technologically to function independently and in positions of managerial responsibility.

Employment opportunities for Civil Engineering Technology program graduates are with town, city, state, or Federal public works departments and agencies; private consulting, engineering, architectural, and construction organizations; and with railroads and the military. Job opportunities will also depend upon the economy and the abilities of the individual.

The Civil Engineering Technology program and related programs offered by Lincoln College are:

Associate in Engineering Degree

Architectural Engineering Technology ..... page 70
Environmental Engineering Technology ..... page 71
Structural Engineering Technology ..... page 72
Surveying and Highway Engineering Technology ..... page 74

Bachelor of Engineering Technology Degree

Civil Engineering Technology ..... page 75
Mechanical-Structural Engineering Technology ..... page 92

Architectural Engineering Technology — Major Code 025

Leading to the Degree of Associate in Engineering

The program in Architectural Engineering Technology offers students the opportunity to prepare to assume responsibilities in the planning, design, and construction of buildings. Employment opportunities are with architectural groups, consulting engineering firms, and government agencies. Job opportunities will also depend upon the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670	09.671		Engineering Graphics I, II	8
		09.600	Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	30.305		English I	3
		93.606	Technical Communications I	3
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
12.444			General Chemistry I	3
	30.306		English II	3
		01.621	Introduction to Structural Design	4
02.611			Mechanics A	4
	02.614	02.615	Stress Analysis A, B	8
39.301	39.302		Economics Principles and Problems I, II	6
			Fourth Year	
01.624			Structural Analysis I	4
	01.691	01.692	Architectural Design I, II*	8
01.690			Technology of Modern Architecture	4
	01.671		Concrete Design I	4
		01.631	Steel Design I	4
			Total A.E. Degree	102

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Environmental Engineering Technology — Major Code 011

Leading to the Degree of Associate in Engineering

The program in Environmental Engineering Technology offers the student the opportunity to prepare to assume responsibilities related to the design, construction, operation, and supervision of municipal plants and systems concerned with the storage and distribution of water, and also the disposal of sewage and waste in urban areas with strong considerations regarding contamination and pollution. Employment opportunities are with town, city, and state public works departments, private engineering consultants, archi-

*27.541, 27.542, 27.543 Drawing I, II, III *(Prereq. none)*—a basic drawing course in developing pencil, pen, and wash techniques; and the study of basic drawing problems using a variety of media—may be used to supplement this program.

tects, contractors, and many other engineering organizations. Job opportunities will also depend upon the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	**First Year**	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670	09.671		Engineering Graphics I, II	8
		09.600	Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	30.305		English I	3
		93.606	Technical Communications I	3
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
12.444			General Chemistry I	3
	30.306		English II	3
		01.641	Fluid Mechanics	4
02.611			Mechanics A	4
	02.614	02.615	Stress Analysis A, B	8
39.301	39.302		Economic Principles and Problems I, II	6
			Fourth Year	
01.624			Structural Analysis I	4
	01.650		Environmental Engineering I	4
		01.693	Construction Administration	4
01.661			Materials and Soil Mechanics	4
	01.671		Concrete Design I	4
		01.651	Environmental Engineering II	4
			Total A.E. Degree	102

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Structural Engineering Technology — Major Code 012

Leading to the Degree of Associate in Engineering

The program in Structural Engineering Technology offers the student the opportunity to prepare to assume responsibilities related to the planning, design, and supervision of

the construction of buildings, bridges, foundations; flood-control projects, and all fixed structures. Employment opportunities are with consulting engineering firms, architectural groups, contractors, railroads, government agencies, the military, and other design-related companies. Job opportunities will also depend upon the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring		
			First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670	09.671		Engineering Graphics I, II	8
		09.600	Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	30.305		English I	3
		93.606	Technical Communications I	3
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
12.444			General Chemistry I	3
	30.306		English II	3
		01.621	Introduction to Structural Design	4
02.611			Mechanics A	4
	02.614	02.615	Stress Analysis A, B	8
39.301	39.302		Economic Principles and Problems I, II	6
			Fourth Year	
01.624	01.625		Structural Analysis I, II	8
		01.693	Construction Administration	4
01.661			Materials and Soil Mechanics	4
	01.671		Concrete Design I	4
		01.631	Steel Design I	4
			Total A.E. Degree	102

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Surveying and Highway Engineering Technology — Major Code 013

Leading to the Degree of Associate in Engineering

The program in Surveying and Highway Engineering Technology offers the student the opportunity to prepare to assume responsibilities related to the preparation and calculation of preliminary and legal surveys required for both small projects, such as subdivision work, individual lot layouts, and highway layouts, as well as more complex projects relating to sewer systems, pipelines, power transmission lines, dams, reservoirs, and aqueducts. Employment opportunities are with independent surveying companies, civil engineering companies, highway, transit, and railroad planning groups, as well as cartographers, construction companies, and contractors. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670	09.671		Engineering Graphics I, II	8
		09.600	Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	30.305		English I	3
		93.606	Technical Communications I	3
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
12.444			General Chemistry I	3
	30.306		English II	3
		01.641	Fluid Mechanics	4
02.611			Mechanics A	4
	02.614	02.615	Stress Analysis A, B	8
39.301	39.302		Economic Principles and Problems I, II	6
			Fourth Year	
01.601			Plane Surveying	4
	01.602		Geodetic Surveying	4
		01.611	Highway Engineering	4
01.607			Legal Aspects of Surveying	4
	01.616		Land Use Planning	4
		01.603	Route Surveying	4
			Total A.E. Degree	102

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Civil Engineering Technology — Major Code 014

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology.)

Leading to the Degree of Bachelor of Engineering Technology

The program in Civil Engineering Technology offers the student the opportunity to prepare to assume broad responsibilities related to surveys required to develop initial design criteria and specifications, and to become involved in the planning, design, and construction of all kinds of relatively permanent structures, municipal plants and systems, or transportation systems and facilities. Employment opportunities are in private consulting firms, construction companies, and public works agencies. Work involving surveying, design, and supervision is open to graduates. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670	09.671		Engineering Graphics I, II	8
		09.600	Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	30.305		English I	3
		93.606	Technical Communications I	3
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
12.444			General Chemistry I	3
	30.306		English II	3
		02.615	Stress Analysis B	4
02.611			Mechanics A	4
	02.614		Stress Analysis A	4
		01.641	Fluid Mechanics	4
39.301	39.302		Economic Principles and Problems I, II	6

Fourth Year

01.601			Plane Surveying	4
	01.602		Geodetic Surveying	4
		01.603	Route Surveying	4
( )			Arts and Sciences Elective	3
01.624	01.625		Structural Analysis I, II	8
		01.621	Introduction to Design	4

Fifth Year

01.661			Materials and Soil Mechanics	4
	01.650		Environmental Engineering I	4
		01.672	Concrete Design II	4
( )			Arts and Sciences Elective	3
( )			Arts and Sciences Elective	3
	01.671		Concrete Design I	4
		01.631	Steel Design I	4

Sixth Year

01.632			Steel Design II	4
	01.662		Soil Mechanics and Foundations	4
		01.611	Highway Engineering	4
( )	( )	( )	Arts and Sciences Electives	9
( )	( )	( )	*Lab. Electives	6

Seventh Year

( )	( )	( )	Technical Electives A, B, C	12
( )	( )	( )	Technical Electives A, B, C	12
			Total B.E.T. Degree	182

Suggested Technical Electives A

01.607	Legal Aspects of Surveying	4
01.690	Technology of Modern Architecture	4
01.694	Civil Engineering Computer Application	4
05.660	Engineering Economy	4

Suggested Technical Electives B

01.642	Hydraulics	4
01.616	Land Use Planning	4
01.691	Architectural Design I	4

Suggested Technical Electives C

01.651	Environmental Engineering II	4
01.693	Construction Administration	4
01.692	Architectural Design II	4

*Before registering for any electives, the student should submit a proposed program of elective courses—preferably representing a minor field of concentration consistent with his or her personal career objectives—for approval by the Academic Standing Committee.

Suggested Laboratory Electives

01.310 (Summers only)	Surveying Lab.	2
01.314 01.315	Surveying Practice I, II	4
01.380	Environmental Lab.	2
01.364	Materials and Soil Mechanics Lab.	2
02.673	Measurement and Analysis Lab.	2
02.674	Technology Lab.	2

Elective courses for which proper preparation exists may be chosen from inside or outside the Civil Engineering discipline.

Transfer students may petition for elective credits for courses that are suitable to the curriculum.

Graduates of the Bachelor of Engineering Technology programs desiring to pursue programs leading to the Bachelor of Science in Engineering degree at Northeastern University may apply through the Admissions Office (150 RI). Programs in Electrical, Civil, and Mechanical Engineering are available on a part-time as well as a regular cooperative program. Industrial and Chemical Engineering programs are available only during the regular day programs.

Candidates must have at least a 2.75 cumulative average and complete a course program prescribed by the major department and the Dean's Office.

ELECTRICAL ENGINEERING TECHNOLOGY PROGRAMS

Electrical Engineering deals with the design and operation of equipment and systems related to power, communications, data processing, and electrical control. Its major functions are: 1) the generation, transmission, and distribution of electrical energy for light and power purposes; 2) the development and production of equipment for telephone, radio, television, radar, and communication; 3) the design and construction of data processing systems and analog or digital computers; and 4) the application of electrical and electronic devices in the control of processes and manufacture.

Employment opportunities for the Electrical Engineering Technology graduate are in public and private research laboratories, engineering consulting groups dealing with industrial and plant applications, design organizations dealing with operation and manufacture, sales engineering, and the electric utility industry. Job opportunities will depend on the economy and the individual's abilities.

The Electrical Engineering Technology program and related programs offered by Lincoln College are:

Associate in Engineering Degree

Electrical Engineering Technology ..... page 78

Bachelor of Engineering Technology Degree

Electrical Engineering Technology ..... page 79
(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

The program in Electrical Engineering Technology leading to the Bachelor of Engineering Technology is also offered as a day cooperative program. A specimen curriculum is shown on page 89. For further information please call (617) 437-2200, or write:

Dean of Admissions
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

Electrical Engineering Technology — Major Code 033

Leading to the Degree of Associate in Engineering

The program in Electrical Engineering Technology offers the student the opportunity to prepare to assume responsibilities related to the design, development, and operation of communications, data processing, and electronic control equipment for applications in computers, military and space explorations, and in automated industrial production equipment. Employment opportunities are in communications equipment, electrical manufacturing, data processing and control, equipment organizations, as well as other engineering-oriented companies. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670		09.672	Eng. Graphics I, Elect. Eng. Graphics	8
	09.600		Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	11.673	11.674	Physics Laboratory I, II	4
10.621			Calculus A	4
	30.305		English I	3
		93.606	Technical Communications I	3
			Third Year	
10.622	10.623*		Calculus B, C	8
		02.619	Mechanics	4
03.651	03.652		Circuit Analysis I, II	8
		30.306	English II	3
03.624		03.625	Circuits Laboratory I, II	4

*Arts and sciences elective may substitute for 10.623

Fourth Year

03.611	03.612	03.613	Electronics I, II, III	12
03.653**	03.654†		Circuit Analysis III, IV	8
		03.610	Electrical Measurements	4
		03.623	Electronic Laboratory	2
			Total A.E. Degree	103

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Electrical Engineering Technology — Major Code 035

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

Leading to the Degree of Bachelor of Engineering Technology

The program in Electrical Engineering Technology offers the student the opportunity to prepare to assume broad responsibilities related to the design, development, operation, installation, and production of a wide variety of electrical and electronic equipment concerned with the generation and utilization of electric energy, communications, data processing, and industrial control. Employment opportunities are in public and private research laboratories, engineering consulting firms dealing with industrial and plant applications, electric utilities, electrical and electronic organizations concerned with operation, manufacture, installation, and sales. Job opportunities will also depend on the economy and the student's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	**First Year**	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670		09.672	Eng. Graphics I, Elect. Eng. Graphics	8
	09.600		Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
	11.673	11.674	Physics Laboratory I, II	4
10.621			Calculus A	4
	30.305		English I	3
		93.606	Technical Communications I	3

*03.614 may substitute for 03.653.

* *Technical elective may substitute for 03.654.

Third Year

10.622	10.623		Calculus B, C	8
		02.619	Mechanics	4
03.651	03.652		Circuit Analysis I, II	8
		30.306	English II	3
03.624		03.625	Circuits Laboratory I, II	4

Fourth Year

03.611	03.612	03.613	Electronics I, II, III	12
03.653	03.654		Circuit Analysis III, IV	8
		03.610	Electrical Measurements	4
		03.623	Electronics Laboratory	2

Fifth Year

03.614			Pulse & Digital I	4
	03.( )		Technical Elective	4
		03.630	Energy Conversion	4
( )	( )	( )	Arts and Sciences Elective	9
03.627	03.628		Advanced Electronics Labs. I, II	4

Sixth Year

03.670	03.671		Digital Computers I, II	8
		03.637	Distributed Systems	4
( )	( )	( )	Arts and Sciences Electives	9
		03.( )	Technical Elective	4
	03.629		Advanced Electronics Lab. III	2

Seventh Year

03.( )	03.( )		Technical Electives	8
	03.677	03.678	Control Engineering I, II	8
( )	( )	( )	Arts and Sciences Electives	9
			Total B.E.T. Degree	180

Suggested Technical Electives

02.621			Thermodynamics	4
02.631			Materials A	4
03.330			Microwave Measurements	2
03.381	03.382	03.383	Linear Active Circuit Design I, II, III	6
03.396			Basic Optics for Instrumentation	2
03.397	03.398		Optical Instrumentation I, II	4
03.531	03.532	03.533	Digital Signal Processing	6
03.615			Pulse & Digital II	4
03.617	03.618	03.619	Principles of Communication Systems I, II, III	12
03.662	03.663	03.664	Basic Power Systems I, II, III	12
04.381	04.382	04.383	Nuclear Technology I, II, III	6
05.660			Engineering Economy I	4
05.590	05.591		Engineering Probability & Statistics I, II	4
09.601			Fortran Engineering Computation	4
09.670			Introduction to CPU Hardware	4

09.671	CPU Hardware Architecture	4
11.624	Introductory Survey of Lasers	2

Electrical Engineering Technology courses of an elective nature may be chosen from the above list of courses.

Elective courses for which proper preparation exists may be chosen from inside or outside the Electrical Engineering discipline.

Graduates of the Bachelor of Engineering Technology program desiring to pursue programs leading to the Bachelor of Science in Engineering degree at Northeastern University may apply through the Admissions Office (150 RI). Programs in Electrical, Civil, and Mechanical Engineering are available on a part-time as well as a regular cooperative program. Industrial and Chemical Engineering programs are available only during the regular day programs.

Candidates must have at least a 2.75 cumulative average and complete a course program prescribed by the major department and the Dean's Office.

*Before registering for any electives, the student should submit a proposed program of elective courses—preferably representing a minor field of concentration consistent with his or her personal career objectives—for approval by the Academic Standing Committee.

03.341, 03.342, 03.343 Power & Control Labs. I, II, III may be substituted for 03.627, 03.628, 03.629 Advanced Electronic Labs. I, II, III.

Electrical Engineering Technology

(Day Cooperative Curriculum)

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

Leading to the Degree of Bachelor of Engineering Technology

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.407	10.408		College Algebra & Trigonometry I, II	8
		10.420	Calculus I	4
11.417	11.418	11.419	Physics I, II, III	12
30.113			Freshman Writing	4
	30.114		Introduction to Literature	4
		30.206	The Literature of Engineering	4
09.470		09.471	Engineering Graphics I, II	8
	11.473	11.474	Physics Laboratory I, II	4
	09.400		Computer Programming for Eng. Tech.	4
			Second Year	
10.421	10.422		Calculus A, B	8
03.451	03.452		Circuit Analysis I, II	8
39.115			Principles of Economics	4
	02.419		Mechanics	4
( )	( )		Social Science/Humanities Electives	8
	03.424		Circuits Laboratory I	2

Third Year

03.453	03.454		Circuit Analysis III, IV	8
03.411	03.412		Electronics I, II	8
03.460			Engineering Analysis I	4
	03.410		Electrical Measurements	4
03.425	03.423		Circuits Lab. II, Electronics Lab.	4

Fourth Year

03.430			Energy Conversions	4
03.413			Electronics III	4
	03.414		Pulse & Digital I	4
03.427	03.428		Advanced Electronics Lab. I, II	4
03.( )	03.( )		Technical Electives	8
( )	( )		Social Science/Humanities Electives	8
	03.437		Distributed Systems	4

Fifth Year

03.477	03.478		Control Engineering I, II	8
03.470	03.471		Digital Computers I, II	8
03.( )	03.( )		Technical Electives	8
03.429			Advanced Electronics Lab. III	2
	( )		Social Science/Humanities Elective	4
			Total B.E.T. Degree	180

Suggested Technical Electives

02.421	02.422		Thermodynamics A, B	8
02.431	02.432		Materials A, B	8
03.415			Pulse & Digital II	4
03.417	03.418	03.419	Principles of Communication Systems I, II, III	12
03.462	03.463	03.464	Basic Power Systems I, II, III	12
03.490			Optical Measurements	4
04.481			Nuclear Technology	4

Note: Students desiring to terminate their program at the end of Quarter 7 may petition to be awarded the Associate in Engineering degree.

Graduates of the day Bachelor of Engineering Technology program who have maintained a superior level of achievement and who wish to continue their academic studies may be qualified to enter the part-time or full-time program leading to the Bachelor of Science in Engineering. For further information, contact the Lincoln College Office at 408 Churchill Hall, telephone 437-2500.

MECHANICAL ENGINEERING TECHNOLOGY PROGRAMS

Mechanical Engineering deals with the harnessing of power resources by means of machinery to perform useful work. In contrast to civil engineering, which deals primarily with static forces and structures, mechanical engineering

is more concerned with the motion and kinetics of devices which are activated by hydraulic, electrical, mechanical, or thermodynamic forces. Major functions of the mechanical engineer are: 1) design and installation of all kinds of machinery, from pocket watches to the largest of steel boring mills; 2) development and production of engines and transportation equipment (automobile, aircraft, ship, railway, etc.); 3) construction and operation of furnaces, boilers, and heating and air-conditioning equipment for the control of atmospheric and environmental conditions.

Employment opportunities for Mechanical Engineering Technology graduates are in the areas of 1) research, design, or development; 2) production, operation, testing, or control; 3) installation, maintenance, and sales. In performing these functions, graduates will work in close association with professionals in the field and may develop technologically so as to function independently and in positions of managerial responsibility. Job opportunities will also depend on the economy and the individual's abilities.

The Mechanical Engineering Technology program and related programs offered by Lincoln College are:

Associate in Engineering Degree

Mechanical Engineering Technology ..... page 83

Bachelor of Engineering Technology Degree

Mechanical Engineering Technology (Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology) ..... page 84
Mechanical—Structural Engineering Technology ..... page 92
(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

The program in Mechanical Engineering Technology leading to the Bachelor of Engineering Technology is also offered as a day cooperative program. A specimen curriculum is shown on page 87. For further information please call (617) 437-2200, or write:

Dean of Admissions
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

Mechanical Engineering Technology **Major Code 021**

Leading to the Degree of Associate in Engineering

The program in Mechanical Engineering Technology offers the student the opportunity to prepare to assume responsibilities related to the design, production, and installation of mechanical tools, machinery, engines, and transportation equipment in which there

is an intermingling of mechanical and hydraulic forces. Because of the increased mechanization of all industry, varied employment opportunities are available in private engineering consultant groups, in light and heavy industries, and in almost all engineering design organizations. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670		09.671	Engineering Graphics I, II	8
	09.600		Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
10.621			Calculus A	4
	30.305		English I	3
		93.606	Technical Communications I	3
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
10.622			Calculus B	4
	09.664		Design Graphics	4
		02.631	Materials A	4
02.611	02.612		Mechanics A, B	8
		02.614	Stress Analysis A	4
			Fourth Year	
02.615			Stress Analysis B	4
	02.621		Thermodynamics A	4
		02.643	Fluid Mechanics A	4
02.673			Measurement & Analysis Lab.	2
	02.674	02.675	Technology Laboratory A, B	4
( )			Arts and Sciences Elective	3
	30.306		English II	3
		39.301	Economic Principles & Problems I	3
			Total A.E. Degree	101

Mechanical Engineering Technology **Major Code 023**

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

Leading to the Degree of Bachelor of Engineering Technology

The program in Mechanical Engineering Technology offers the student the opportunity to prepare to assume broad responsibilities related to the design, development, produc-

tion, operation, and installation of all kinds of machinery, engines, and transportation equipment, as well as boilers, furnaces, and heating or air-conditioning equipment which involve interactions of mechanical, hydraulic, and thermodynamic forces. Employment opportunities are in industry producing mechanized and automated equipment, in design and engineering organizations, and in companies dealing primarily with manufacture and production. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements in Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670		09.671	Engineering Graphics I, II	8
	09.600		Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
10.621			Calculus A	4
	30.305		English I	3
		93.606	Technical Communications I	3
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
10.622			Calculus B	4
	09.664		Design Graphics	4
		02.631	Materials A	4
02.611	02.612		Mechanics A, B	8
		02.614	Stress Analysis A	4
			Fourth Year	
02.615			Stress Analysis B	4
	02.621		Thermodynamics A	4
		02.643	Fluid Mechanics A	4
02.673			Measurement & Analysis Lab.	2
	02.674	02.675	Technology Laboratory A, B	4
( )			Arts and Sciences Elective	3
	30.306		English II	3
		39.301	Economic Principles & Problems I	3
			Fifth Year	
02.613			Mechanics C	4
	02.622		Thermodynamics B	4
		02.623	Refrigeration & Air Conditioning	4

05.660			Engineering Economy	4
	02.644		Fluid Mechanics B	4
		02.632	Materials B	
		or		
		02.616	Stress Analysis C	4
			Sixth Year	
02.630			Heat Transfer	4
	02.680	02.681	Mechanical Design A, B	8
02.676	02.677	02.678	Technology Laboratory C, D, E	6
( )	( )	( )	Arts and Sciences Electives	9
			Seventh Year	
( )	( )	( )	Technical Electives	12
( )		( )	Arts and Sciences Electives	6
	03.620		Electricity & Electronics	4
( )	( )		Arts and Sciences Electives	6
			Total B.E.T. Degree	180

Suggested Technical Electives

		01.601	Plane Surveying	4
		01.631	Steel Design I	4
		01.671	Concrete Design	4
		02.616	Stress Analysis C	4
		02.632	Materials B	4
		02.633	Applied Metallurgy	4
		02.651	Mechanical Vibrations	4
		02.652	Experimental Stress Analysis	4
		02.679	Power Generation	4
		03.621	Electricity and Electronics II	4
	05.582	05.583	Industrial Technology I, II	4
04.381	04.382	04.383	Nuclear Technology I, II, III	6
		09.601	Fortran Engineering Computation	4

Transfer students may petition for elective credits for courses that are suitable to the curriculum.

Graduates of the Bachelor of Engineering Technology program desiring to pursue programs leading to the Bachelor of Science in Engineering degree at Northeastern University may apply through the Admissions Office (150 RI). Programs in Electrical, Civil, and Mechanical Engineering are available on a part-time as well as a regular day cooperative program. Industrial and Chemical Engineering programs are available only during the regular day programs.

Candidates must have at least a 2.75 cumulative average and complete a course program prescribed by the major department and the Dean's Office.

---

*Before registering for any electives, the student should submit a proposed program of elective courses—preferably representing a minor field of concentration consistent with his or her personal career objectives—for approval by the Academic Standing Committee.

10.623 Calculus C is recommended for all students planning advanced engineering technology subjects.

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Mechanical Engineering Technology

(Day Cooperative Curriculum)

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology)

Leading to the Degree of Bachelor of Engineering Technology

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.407	10.408		College Algebra & Trigonometry I, II	8
		10.420	Calculus I	4
11.417	11.418	11.419	Physics I, II, III	12
30.113			Freshman Writing	4
	11.473	11.474	Physics Labs. I. II	4
09.470			Engineering Graphics I	
or				4
06.400			Computer Programming for Eng. Tech.	
	30.114		Introduction to Literature	4
		30.206	The Literature of Engineering	4
	09.400		Computer Programming for Eng. Tech.	
	or			4
	09.470		Engineering Graphics I	
		09.471	Engineering Graphics II	4
			Second Year	
10.421	10.422		Calculus A, B	8
09.464			Engineering Design Graphics	4
02.411			Mechanics A	4
	02.412		Mechanics B	4
	02.414		Stress Analysis A	4
03.420			Electricity & Electronics I	4
	( )		Social Science/Humanities Elective	4
			Third Year	
02.415			Stress Analysis B	4
	02.431		Materials A	4
02.473			Measurement & Analysis Lab.	2
	02.474		Technology Lab. A	2
02.421	02.422		Thermodynamics A, B	8
02.413			Mechanics C	4
	02.443		Fluid Mechanics A	4
39.115			Economic Principles & Problems	4

Note: Students desiring to terminate their program at the end of Quarter 7 may petition to be awarded the Associate in Engineering degree.

Fourth Year

02.480	02.481	Mechanical Design A, B	8
02.475	02.476	Technology Labs. B, C	4
02.444		Fluid Mechanics B	4
	02.423	Refrigeration & Air Conditioning	4
02.461		Machine Shop (Industrial Engineering Elective on petition with experience)	4
	( )	Social Science/Humanities Elective	4
( )		Social Science/Humanities Elective	4

Fifth Year

02.477	02.478	Technology Labs. D, E	4
05.460		Engineering Economy	4
	02.430	Heat Transfer	4
( )		Social Science/Humanities Elective	4
	( )	Technical Elective	4
( )		Technical Elective	4
	( )	Social Science/Humanities Elective	4
02.432		Materials B	
		or	
02.416		Stress Analysis C	4
		Total B.E.T. Degree	180

Technical Electives Must be Chosen from the Following List:

02.416	Stress Analysis C	4
02.452	Exp. Stress Analysis	4
02.451	Mech. Vibrations	4
02.432	Materials B	4
02.433	Applied Metallurgy	4
02.479	Power Generation	4
10.423	Differential Equations	4
03.421	Electricity & Electronics II	4
03.490	Optical Instrumentation	4
04.481	Nuclear Technology	4

Graduates of the day Bachelor of Engineering Technology program who have maintained a superior level of achievement and who wish to continue their academic studies may be qualified to enter the part-time or full-time program leading to the Bachelor of Science in Engineering. For further information contact the Lincoln College Office at 408 Churchill Hall, telephone 437-2500.

INTERDISCIPLINARY ENGINEERING AND SCIENCE TECHNOLOGY PROGRAMS

These programs offered by Lincoln College present a variety of interdisciplinary combinations of the Engineering Technology programs and the Science programs (chemistry, physics, and mathematics). They have been developed to meet the need for technologists in the areas of ecology, bioelectronic devices, computer systems, and other technological applications requiring an expertise in several of the academic disciplines.

This demand for multi-skilled technologists reflects the increased reliance of society on the science and engineering technologist to help solve its growth problems. Opportunities are also developing in highly interdisciplinary fields such as ocean engineering, bioengineering, environmental science, and public health.

The programs are designed to offer the student the opportunity to prepare to meet the challenge of interfacing technology and society. The engineering technology student not only learns about related disciplines, but also becomes oriented in the disciplines to which his or her technological skills will be applied. A program of concentrated study in chemistry and physics or mathematics and physics is offered to the science technology student.

Interdisciplinary Engineering and Science Technology programs offered to Lincoln College students are:

Associate in Engineering Degree

Computer Technology ..... page 89

Bachelor of Engineering Technology Degree

Mechanical-Structural Engineering Technology ..... page 92
Computer Technology ..... page 90

Computer Technology — Major Code 036

Leading to the Degree of Associate in Engineering

The Computer Technology program offers students the opportunity to provide themselves with the mathematical and technological background for understanding both the hardware and software aspects of computer systems, and so will be prepared as: a) programmers who translate engineering, scientific, and business concepts into meaningful form for the computer; b) engineering technicians concerned with the development, specification, production, and operation of computer hardware; and c) applications technicians dealing with the interface of the computer with industrial process and control systems or data acquisition, reduction, and display systems. Job opportunities will also depend on the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	**First Year**	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4

		10.620	Calculus I	4
09.605			Introduction to Programming	4
	09.670		Engineering Graphics I	4
		09.650	Basic Computer Organization	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
	30.305		English I	3
		93.404	Technical Communications	3
			Third Year	
10.622			Calculus B	4
	09.610		Fortran	4
		09.668	Semiconductor Logic	4
03.651	03.652		Circuit Analysis I, II	8
		30.306	English II	3
		( )	Arts and Sciences Elective	3
			Fourth Year	
09.640			Modern Programming Techniques	4
	09.645		Assembly Language	4
		09.674	Introduction to CPU Hardware	4
09.669			Computer Logic	4
	03.611		Electronics I	4
		09.620	Cobol	4
			Total A.E. Degree	100

Note: Associate degree graduates may transfer applicable credits toward the requirements in other Lincoln College programs leading to the Associate in Engineering, Associate in Science, or Bachelor of Engineering Technology degree.

Computer Technology — Major Code 037

Leading to the Degree of Bachelor of Engineering Technology

The Computer Technology program offers students the opportunity to prepare themselves to be knowledgeable in both hardware and software. The balance of hardware and software courses combined with hands-on laboratory experience provides the student with the opportunity to develop the skill for interfacing the computer with process plants or machinery. Other employment possibilities exist in programming the computer for engineering, scientific, and business applications; designing, engineering, and testing computers; and interfacing computers with various types of equipment for automated drafting, data collection, and display. Job opportunities will also depend upon the economy and the individual's abilities.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.605			Introduction to Programming	4
	09.670		Engineering Graphics I	4
		09.650	Basic Computer Organization	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
10.621			Calculus A	4
	11.673	11.674	Physics Laboratory I, II	4
	30.305		English I	3
		93.606	Technical Communications I	3
			Third Year	
10.622			Calculus B	4
	09.610		Fortran	4
		09.668	Semiconductor Logic	4
03.651	03.652		Circuit Analysis I, II	8
		30.306	English II	3
		( )	Arts and Sciences Elective	3
			Fourth Year	
09.640			Modern Programming Techniques	4
	09.645		Assembly Language	4
		09.674	Introduction to CPU Hardware	4
09.669			Computer Logic	4
	03.611		Electronics I	4
		09.620	Cobol	4
			Fifth Year	
09.675			CPU Hardware Architecture	4
	09.651		Advanced Computer Organization	4
		09.( )	Computer Technical Elective	4
09.630			Non-Numerical Algorithms	4
	( )	( )	Arts and Sciences Elective	6
		39.301	Economic Principles and Problems	3
	( )	( )	Arts and Sciences Elective	6
			Sixth Year	
09.655			Micro-Peripheral Hardware	4
	09.635		Numerical Algorithms	4
		09.680	Data Communications Methods	4

09.( )			Computer Technical Elective	4
	( )		Arts and Sciences Elective	3
		( )	Technical Elective	4
	( )		Arts and Sciences Elective	3

Seventh Year

09.660			Industry Software	4
	09.665		Industry Hardware	4
		09.( )	Computer Technical Elective	4
09.656			Complex Peripheral Hardware	4
	( )		Technical Elective	4
		( )	Arts and Sciences Elective	3
		( )	Arts and Sciences Elective	3
			Total B.E.T. Degree	180

Computer Technical Electives

09.681	Operating Systems
09.682	Computer Graphics Programming
09.683	Data Bases
09.684	Large System Assembly Languages
09.685	Introduction to Simulation Programming
09.686	Device System Hardware
09.687	Bit Slice Microcomputers
09.688	Micro Controllers
09.689	Single Chip Micro Processors
09.690	Special Problems in Computer Technology

All other technical electives may be chosen from other engineering technology or science disciplines within Lincoln or University colleges, subject to the department chairperson's approval.

Graduates of the Bachelor of Engineering Technology program desiring to pursue programs leading to the Bachelor of Science in Engineering degree at Northeastern University may apply through the Admissions Office (150 RI). Programs in Electrical, Civil, and Mechanical Engineering are available on a part-time as well as a regular cooperative program. Industrial and Chemical Engineering programs are available only during the regular day programs.

Candidates must have at least a 2.75 cumulative average and complete a course program prescribed by the major department and the Dean's Office.

Mechanical-Structural Engineering Technology — Major Code 015

(Accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology.)

Leading to the Degree of Bachelor of Engineering Technology

The program in Mechanical-Structural Engineering Technology is interdisciplinary in that it provides the opportunity for students to prepare themselves to assume responsibilities related to both the planning and construction of relatively static structures such as buildings, bridges, and docks, and also the design and production of dynamic machine tools, machinery, and other mechanical devices. The mechanical and structural content

is integrated so as to be complementary and to provide a broad base for design problems of great variety. Employment opportunities lie in the architectural, construction, civil, and mechanical professions and companies.

Prerequisite: Satisfactory completion of the Mathematics Placement Test or the Introductory Mathematics I and II courses (10.681 and 10.682). The Mathematics Placement Test must be taken prior to registration.

Each student in English I (30.305) will take a Placement Examination during class. Some students may be requested to register for Elements of Writing (30.304), a 3 q.h. course designed to upgrade the student's background.

Fall	Winter	Spring	First Year	
Course Number				Q.H.
10.607			College Algebra	4
	10.608		Introduction to Calculus	4
		10.620	Calculus I	4
09.670		09.671	Engineering Graphics I, II	8
	09.600		Computer Programming for Eng. Tech.	4
			Second Year	
11.617	11.618	11.619	Physics I, II, III	12
10.621			Calculus A	4
	30.305		English I	3
		93.606	Technical Communications I	3
	11.673	11.674	Physics Laboratory I, II	4
			Third Year	
10.622			Calculus B	4
02.611			Mechanics A	4
		02.631	Materials A	4
02.612			Mechanics B	4
	02.614		Stress Analysis A	4
		02.643	Fluid Mechanics A	4
			Fourth Year	
02.615			Stress Analysis B	4
	02.644		Fluid Mechanics B	4
		01.621	Introduction to Structural Design	4
02.673			Measurement & Analysis Lab.	2
	02.674	02.675	Technology Laboratory A, B	4
( )			Arts and Sciences Elective	3
	30.306		English II	3
		39.301	Economic Principles & Problems I	3
			Fifth Year	
02.613			Mechanics C	4
	01.625		Structural Analysis II	4
		01.631	Steel Design I	4
01.624			Structural Analysis I	4
	( )	( )	Technical Electives	8

Sixth Year

01.632			Steel Design II	4
	01.671	01.672	Concrete Design I, II	8
( )			Arts and Sciences Elective	3
	( )	( )	Technical Electives	8
( )	( )		Arts and Sciences Electives	6

Seventh Year

	02.680	02.681	Mechanical Design A, B	8
( )			Technical Elective	4
( )		( )	Arts and Sciences Electives	6
	( )		Laboratory Elective	2
( )	( )		Arts and Sciences Electives	6
			Total B.E.T. Degree	180

Suggested Technical Electives

01.601	Plane Surveying	4
01.661	Materials & Soil Mechanics	4
01.662	Soil Mechanics & Foundations	4
01.693	Construction Administration	4
02.616	Stress Analysis C	4
02.621	Thermodynamics A	4
02.632	Materials B	4
02.633	Applied Metallurgy	4
02.651	Mechanical Vibrations	4
02.652	Experimental Stress Analysis	4
05.590	Engineering Probability & Statistics I	4
05.591	Engineering Probability and Statistics II	4
09.601	Fortran Engineering Computation	4

Elective courses for which proper preparation exists may be chosen from inside or outside of the Mechanical-Structural Engineering discipline.

Transfer students may petition for elective credits for courses that are suitable to the curriculum.

Graduates of the Bachelor of Engineering Technology program desiring to pursue programs leading to the Bachelor of Science in Engineering degree at Northeastern University may apply through the Admissions Office (150 RI). Programs in Electrical, Civil, and Mechanical Engineering are available on a part-time as well as a regular cooperative program. Industrial and Chemical Engineering programs are available only during the regular day programs.

Candidates must have at least a 2.75 cumulative average and complete a course program prescribed by the major department and the Dean's Office.

Before registering for any electives, the student should submit a proposed program of elective courses—preferably representing a minor field of concentration consistent with his or her personal career objectives—for approval by the Academic Standing Committee. 10.622, 10.623 are recommended for all students planning advanced engineering technology subjects.

description of courses

On the pages which follow is a numerical and descriptive listing of courses offered in the several curricula of Lincoln College. Although not all courses are offered every year, all will be offered during the normal period of each student's curriculum, except for those special courses as defined in the departmental heading of the following course descriptions. The term "prerequisite" indicates a course that must be taken before undertaking the advanced course to which it applies.

A "quarter hour" equals approximately three clock hours of work (approximately fifty minutes of class and two hours of preparation a week for a quarter of 12 weeks' duration). Laboratory and drawing courses normally require fewer hours of outside preparation and therefore carry less credit than lecture courses.

Abbreviations

prereq.—prerequisite
coreq.—corequisite
cl.—class hours
lab.—laboratory hours
q.h.—quarter hours

Policy on Changes of Program

Lincoln College reserves the right to cancel, modify, or add to the courses offered, or to change the order or content of courses in any curriculum.

The University further reserves the right to change the requirements for graduation, tuition, fees charged, and other regulations. However, no change in tuition and fees at any time shall become effective until the school year following that in which it is announced.

Any changes which may be made from time to time relative to the above policy shall be applicable to all students in the school, college, or department concerned, including former students who may re-enroll.

INDEX TO COURSES

Dept. No.		Pages
01	*Civil Engineering Technology*	*96*
02	*Mechanical Engineering Technology*	*99*
03	*Electrical Engineering Technology*	*107*
04	*Chemical Engineering Technology*	*116*
05	*Industrial Engineering Technology*	*116*
09	*Computer Technology*	*117*
09	*Engineering Graphics*	*121*
10	*Mathematics*	*122*
11	*Physics*	*126*
93	*Supplemental Courses (Lincoln College)*	*127*
96	*Aeronautical Technology*	*130*

CIVIL ENGINEERING TECHNOLOGY

01.310 Surveying Laboratory (3 lab., 2 q.h.)
An outdoor lab in use of level, transit, and plane table. Level circuits and a transit-tape traverse are run. Topography and layout problems are given. *Prereq. 01.601.*

01.314 Surveying Practice I (1 cl., 2 lab., 2 q.h.)
Computing and balancing a control traverse; calculating exact property lines, vertical control survey; plotting from topographic field notes. *Prereq. 01.603.*

01.315 Surveying Practice II (1 cl., 2 lab., 2 q.h.)
Scale drawing of the proposed subdivision; calculations required by the land court for the subdivision; street profiles showing grades; drainage study. *Prereq. 01.314.*

01.364 Materials and Soil Mechanics Lab. (3 lab., 2 q.h.)
Grain size analysis; specific gravity; CBR optimum moisture; direct shear· seepage and flow nets; consolidation test. *Prereq. 01.661.*

01.601 Plane Surveying (4 cl., 4 q.h.)
Surveying principles; theory of measurements; leveling; traverse computations; area calculation; stadia principles and topography. *Prereq. 10.608.*

01.602 Geodetic Surveying (2 cl., 4 lab., 4 q.h.)
Introduction to practical astronomy for surveying, including basic spherical trigonometry. Introduction to geodetic surveying, including precise leveling, triangulation, EDM equipment, and base line measurements. *Prereq. 01.601.*

01.603 Route Surveying (4 cl., 4 q.h.)
Simple and compound curves; vertical curves; earthwork computations; solution of the mass diagram; introduction to route location by photogrammetry. *Prereq. 01.601.*

01.607 Legal Aspects of Surveying (4 cl., 4 q.h.)
Registry of deeds and probate; ownership of land; deeds, descriptions and qualifying expressions; adverse possession; Massachusetts land court; expert witness. *Prereq. 01.601.*

01.611 Highway Engineering (4 cl., 4 q.h.)
Engineering considerations in the planning and construction of modern highways and highway routing; traffic flow and traffic control; computer applications to transportation problems. *Prereq. 01.601.*

01.616 Land Use Planning (4 cl., 4 q.h.)
Environmental, sociological, economic aspects, and traditional basis for land use planning. Objectives, content, form and preparation of plan. Community and public facilities, transportation; environmental impact and plan implementation. *Prereq. 09.671.*

01.621 Introduction to Structural Design (2 cl., 4 lab., 4 q.h.)
Tabular methods for the design of members and connections using the AISC Code. *Prereq. 02.614, 09.671.*

01.624 Structural Analysis I (4 cl., 4 q.h.)
Reactions, shears, bending moments, and forces developed by loading systems on beams and trusses. Influence lines for beams, girders and trusses; solutions for forces from moving load systems on statically determinate structures. *Prereq. 02.615.*

01.625 Structural Analysis II (4 cl., 4 q.h.)
Classical methods of deflection solution for beams and trusses. Methods of solving statically indeterminate structures. *Prereq. 01.624.*

01.631 Steel Design I (4 cl., 4 q.h.)
Design of steel members in structural frames; tension, compression, bending and eccentrically loaded members. Design of plate girders for buildings. *Prereq. 01.621, 02.615.*

01.632 Steel Design II (4 cl., 4 q.h.)
Design of steel for highway bridges, composite design in bridges and buildings, introduction to plastic analysis and design in steel. *Prereq. 01.631.*

01.641 Fluid Mechanics (4 cl., 4 q.h.)
Hydrostatics; pressure measurement; hydrostatic forces on submerged areas; simple dams; fluid dynamics; kinematics of flow; continuity, momentum and energy equations; orifices; Pi theorem; laminar and turbulent flow. *Prereq. 02.614.*

01.642 Hydraulics (4 cl., 4 q.h.)
Flow in closed conduits; empirical formulas for closed conduit flow; minor losses; compound pipe systems; open channel flow; specific energy and stage relationships; fluid measurement systems; hydraulic machinery. *Prereq. 01.641.*

01.650 Environmental I (4 cl., 4 q.h.)
Principles of water supply engineering; population forecasting; quality and quantity of water for various uses. Water treatment processes. Collection and disposal of waste water and storm water; modern treatment methods and waste water plant operation. *Prereq. 12.444 and 01.641.*

01.651 Environmental II (2 cl., 4 lab., 4 q.h.)
Layout and design of water treatment and sewage treatment plants. Instrumentation and electrical equipment. Laboratory demonstrations. *Prereq. 01.650.*

01.652 Environmental Lab. (3 lab., 2 q.h.)
Methods and techniques for the physical, chemical, and bacteriological examination of water and waste water, and approaches to treatment through bench scale studies. *Prereq. 01.650.*

01.661 Materials and Soil Mechanics (4 cl., 4 q.h.)
Physical properties of portland cement, aggregates, mixing water and admixtures; batch proportioning; bituminous materials; index properties of soils, soil moisture and structure; compressibility, theory of consolidation. *Prereq. 02.615.*

01.662 Soil Mechanics and Foundations (4 cl., 4 q.h.)
Shear strength of soils, distribution of stress; settlement computations; lateral earth pressures; bearing capacity; soil compaction, soil stabilization, and site investigation. *Prereq. 01.661.*

01.671 Concrete Design I (4 cl., 4 q.h.)
Design of bending members, axially and eccentrically loaded columns by elastic and ultimate strength principles. *Prereq. 02.615.*

01.672 Concrete Design II (4 cl., 4 q.h.)
Reinforced concrete design of basic structures, including considerations of continuity. Introduction to prestressed concrete member design. *Prereq. 01.671.*

01.690 Technology of Modern Architecture (4 cl., 4 q.h.)
General background of architectural styles, both historical and contemporary, with emphasis on engineering design and construction procedures required for the various types of buildings.

01.691 Architectural Design I (4 cl., 4 q.h.)
Basic architectural design concepts; proportion, scale form, massing, color texture, and lighting. Orientation of structures; site organization; selection of building materials. *Prereq. 09.671, 01.690.*

01.692 Architectural Design II (4 cl., 4 q.h.)
Consideration of the building process. Individual architectural design projects assigned by the instructor. *Prereq. 01.691.*

01.693 Construction Administration (4 cl., 4 q.h.)
Contracts, specifications, and bidding procedures; estimating and scheduling, including critical path; discussion of personnel administration and union negotiation. Bid preparation for a small project.

01.694 Civil Engineering Computer Applications (4 cl., 4 q.h.)
An introduction to the systems approach to typical civil engineering problems and their solution using computer applications. *Prereq. 01.625, 01.650, 01.661, 01.603.*

MECHANICAL ENGINEERING TECHNOLOGY

02.411 Mechanics A (4 cl., 4 q.h.) (Day Curriculum)
Forces, moments, couples, statics of particles and rigid bodies in two and three dimensions; distributed forces—external and internal; first moments and centroids; analysis of structure—trusses, frames, and machines. *Prereq. 10.420 or 10.620, 11.417 or 11.617.*

02.412 Mechanics B (4 cl., 4 q.h.) (Day Curriculum)
Friction, second moments, and virtual work; kinematics of particles—rectilinear and curvilinear motion of dynamic particles—force, mass and acceleration, work and energy. *Prereq. 02.411 or 02.611.*

02.413 Mechanics C (4 cl., 4 q.h.) (Day Curriculum)
Impulse and momentum of particles; kinematics and dynamics of rigid bodies—force, mass, and acceleration; dynamics of rigid bodies—work and energy, impulse and momentum; introduction to mechanical vibration. *Prereq. 02.412 or 02.612.*

02.414 Stress Analysis A (4 cl., 4 q.h.) (Day Curriculum)
Axially loaded members; stress and strain, allowable stresses, factor of safety, temperature effects, indeterminate members; thin-walled pressure vessels; centric loading of bolted and welded connection. Shear and moment in beams; eccentrically loaded connections; flexural and transverse shearing stresses in beams. *Prereq. 02.411 or 02.611.*

02.415 Stress Analysis B (4 cl., 4 q.h.) (Day Curriculum)
Determinate and indeterminate beam deflections and reactions by integration and area moment methods. Torsional stresses and strains; power transmission; eccentric loads on struts, beams, riveted and welded joints; combined stresses; principal stresses; Mohr's circle; theories of failure. *Prereq. 02.414 or 02.614*

02.416 Stress Analysis C (4 cl., 4 q.h.) (Day Curriculum)
Curved beams; nonsymmetrical bending of beams; shear-center and shear stresses on thin sections; composite beams. Columns; energy absorption and resilience; inertial stresses, impact loading; deflection of beams by energy methods. Bolted fastenings. *Prereq. 02.415 or 02.615.*

02.419 Mechanics (4 cl., 4 q.h.) (Day Curriculum)
A mechanics course for nonmechanical students. *Prereq. 10.420 or 10.620, 11.417 or 11.617.*

02.421 Thermodynamics A (4 cl., 4 q.h.) (Day Curriculum)
General theory of heat and matter; laws of thermodynamics; energy-transformation principles and availability of energy; properties and processes for pure substances and ideal gases. Thermodynamic properties and processes of liquids and vapors; tables and charts; mixtures of fluids; vapor cycles. *Prereq. 11.418 or 11.618.*

02.422 Thermodynamics B (4 cl., 4 q.h.) (Day Curriculum)
Theory of vapor engines and analysis of types of actual engines using compression of gases and vapors; internal combustion engines. Theory of gas and vapor flow through orifices and nozzles. Design and performance of steam and gas turbines; spark-ignition and compression-ignition engine design and performance. Fan performance. *Prereq. 02.421 or 02.621.*

02.423 Refrigeration & Air Conditioning (4 cl., 4 q.h.) (Day Curriculum)
Air conditioning principles, including psychometrics and heat pumps. Calculation of heating and cooling loads in accordance with A.S.H.R.A.E. practices. Principles of gas compression; analysis of vapor compression; refrigeration systems; low-temperature refrigeration cycles; and absorption refrigeration systems. *Prereq. 02.422 or 02.622.*

02.430 Heat Transfer (4 cl., 4 q.h.) (Day Curriculum)
The primary modes of heat transfer; thermal conductivity; thermal conductance/resistance concept; thermal-electrical analogy; combined heat transfer mechanisms, basic equations of conduction; analytical solutions of various steady state conduction problems. Dimensional analysis and similarity considerations; natural and forced convection; hydrodynamic and thermal boundary layers; black body radiation; Kirchhoff's law; emissivity and absorptivity; radiation between simple bodies; numerical methods. Log mean temperature differences; overall heat transfer coefficients; heat exchanger effectiveness; tubular exchanger design; regenerative and evaporative heat exchangers; heat transfer engineering problems. *Prereq. 02.422 or 02.622.*

02.431 Materials A (4 cl., 4 q.h.) (Day Curriculum)
Lectures on: fundamental metallic structures; general metallurgical information covering theoretical aspects of properties; testing and failure of metals; supplemented by visual aids. Lectures on: alloying and hardening of metals; refinement of metals; equilibrium diagrams; characteristics of engineering metals; principles of metal fabrication.

02.432 Materials B (4 cl., 4 q.h.) (Day Curriculum)
Lectures on: inorganic materials, i.e., polymers, glasses, ceramics, cements, wood, and materials having important electrical and magnetic properties; also a summary of the most up-to-date applications for the fabrication and uses of both metals and nonmetals. Structures of metals; imperfections; phase diagrams; effect of temperature on structure and properties of metals (annealing, recrystallization, recovery, precipitation, diffusion); strengthening mechanisms; mechanical properties of nonferrous metals.
Laboratory: experiments in preparation of samples, selection, polishing, and etching; examination of nonferrous metals; use of the microscope; linear analysis; construction of cooling curves; and simple binary phase diagrams. *Prereq. 02.431 or 02.631.*

02.433 Applied Metallurgy (4 cl., 4 q.h.) (Day Curriculum)
Lectures on: mechanical properties of ferrous metals, the iron carbon diagram, high-temperature alloys, hardening methods, impact tests, effects of environment on metals; manufacturing processes; methods of fabrication; limitations on the use of different materials and processes; casting, welding, cutting, drawing, powder metallurgy.
Laboratory: experiments on analysis of stress-strain diagrams of iron and steel, heat treatment of steels, surface corrosion, tempering and drawing, use of metallograph and analysis of the results. Experiments in cold rolling, swaging, drawing of nonferrous metals

and the analysis of the results. Tension, shear, fatigue, and machinability tests on ferrous metals. *Prereq. 02.432 or 02.632.*

02.443 Fluid Mechanics A (4 cl., 4 q.h.) (Day Curriculum)
Hydrostatics, principles governing fluids at rest; pressure measurement; hydrostatic forces on submerged areas and objects; simple dams; fluids in moving vessels; hoop tension. Fluid flow in pipes under pressure; fluid energy, power and friction loss; Bernoulli's Theorem; flow measurement. *Prereq. 02.412 or 02.612.*

02.444 Fluid Mechanics B (4 cl., 4 q.h.) (Day Curriculum)
Pipe networks and reservoir systems; flow in open channels; uniform flow; energy, friction loss, minor losses, velocity distribution, alternate stages of flow, critical flow; nonuniform flow; accelerated and retarded flow; hydraulic jump and waves. *Prereq. 02.443 or 02.643.*

02.451 Mechanical Vibrations (4 cl., 4 q.h.) (Day Curriculum)
Elements of vibrating systems, one degree of freedom (undamped free and forced vibration from Newton's law of motion and energy methods); natural frequencies; damped free and forced vibration; impedance and mobility; systems with more than one degree of freedom; influence coefficients, Lagrange's equations, generalized coordinates, vibration absorber. *Prereq. 02.413 or 02.613.*

02.452 Experimental Stress Analysis (4 cl., 4 q.h.) (Day Curriculum)
Theory and experimentation showing the application of extensometers and electrical strain gauges and as transducers in the field of experimental stress and strain analysis. Theory and laboratory practice on photoelastic methods as applied to classical model analysis and modern coating analysis. *Prereq. 02.415 or 02.615.*

02.461 Machine Shop (2 cl., 3 lab., 4 q.h.) (Day Curriculum)
Introduction to study of machines for metal processing, cutting tools, and fluids; machinability; automatic machinery. *Prereq. none.*

02.473 Measurement & Analysis Laboratory (3 lab., 2 q.h.) (Day Curriculum)
Experimental procedures for the collection and analysis of data by graphical and numerical methods, including computer applications, report writing that draws conclusions which are relative to accuracy, precision, true values, and measured values as they are related to basic mechanical measuring instruments for length, area, volume, specific gravity, pressure, temperature, and time as these parameters are utilized in making mechanical measurements. *Prereq. 02.414 or 02.614, 06.400 or 06.600, 10.422 or 10.622, 11.419 or 11.619.*

02.474 Technology Laboratory A (3 lab., 2 q.h.) (Day Curriculum)
Experimental procedures to determine mechanical properties of materials under tensile, compressive, torsional, direct shear, flexural, impact, fatigue, and creep loading conditions as they are affected by environmental conditions that are normal and abnormal; also as they are affected by homogeneity, nonhomogeneity, isotrophy, and nonisotropy. *Prereq. 02.473 or 02.673, 02.415 or 02.615, 03.431 or 02.631, or concurrently.*

02.475 Technology Laboratory B (3 lab., 2 q.h.) (Day Curriculum)
Experimental procedures to determine the physical properties of incompressible fluids, measure the flow rates and velocities utilizing pitot tubes, oriface plates, venturii meter,

and weirs flow meters, U tube differential manometers, and piezometers as the fluid flows through open channels, partially filled conduits, conduits under pressure, pipe networks, turbines, and pumps. *Prereq. 02.473 or 02.673, 02.443 or 02.643, or concurrently.*

02.476 Technology Laboratory C (3 lab., 2 q.h.) (Day Curriculum)
Basic thermodynamic relationships; experimental procedures to examine the flow of compressible fluids and steam; examine the energy conversion of a fuel into a working substance and the related heat transfer mechanisms. Operating characteristics of thermal generators, engines, and compressors. *Prereq. 02.473 or 02.673, 02.422 or 02.622, or concurrently.*

02.477 Technology Laboratory D (3 lab., 2 q.h.) (Day Curriculum)
Experimental procedures to examine the operating characteristics and efficiencies of internal combustion engines, brake horsepower, indicated horsepower, friction horsepower, mean effective pressure, fuel consumption, torque, ignition timing, manifold pressure, and compression ratios and internal engines as energy conversion systems; energy conversion of fuels. *Prereq. 02.476 or 02.676, 02.422 or 02.622, 02.430 or 02.630, or concurrently.*

02.478 Technology Laboratory E (3 lab., 2 q.h.) (Day Curriculum)
Experimental procedures of a project nature to examine refrigeration, air conditioning, and heating pump cycles. A project of analytical, design, or experimental nature. Experiments of advanced or specialized nature. *Prereq. 02.473 or 02.673, 02.423 or 02.623, 02.430 or 02.630.*

02.479 Power Generation (4 cl., 4 q.h.) (Day Curriculum)
Basic power generation cycles; gas turbine cycles; effects of combustor temperature, intercooling, etc., on cycle performance; Rankine regenerative cycles; effects of steam temperature, pressure, number of feedwater heaters, etc., upon performance; steam generation equipment: boilers, reactors.
Fossil fuel characteristics and effects on boiler design; combustion analysis; draft calculations; axial and centrifugal fan performance characteristics; pump design and performance considerations; heat exchanger design considerations.
Applications of principles of economics to cycle and performance considerations; use of load curves; economic considerations of heat rate; economics of equipment selection; study of auxiliary equipment such as precipitators and flue gas desulfurization systems. *Prereq. 02.422 or 02.622.*

02.480 Mechanical Design A (4 cl., 4 q.h.) (Day Curriculum)
Introduction to mechanical design, the design process, design factors, creativity, optimization, human factors, value engineering. These principles discussed and developed in an introductory manner through simple design projects.
Principles of design, properties, and selection of materials; stress concentrations; strength under combined stresses; theories of failure; impact and fluctuating and repeated loads. *Prereq. 02.415 or 02.615 or 02.431 or 02.631.*

02.481 Mechanical Design B (4 cl., 4 q.h.) (Day Curriculum)
Stresses; deformation and design of fasteners, screws, joints, springs, and bearings; lubrication and journal bearings.

Stresses and power transmission of spur, bevel, and worm gear; shaft design; clutches and brakes. *Prereq. 02.480 or 02.680.*

02.499 Special Problems in Mechanical Engineering Technology (4 q.h.)
(Day Curriculum)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

02.598 Special Problems in Mechanical Engineering Technology (2 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

02.599 Special Problems in Mechanical Engineering Technology (4 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

02.611 Mechanics A (4 cl., 4 q.h.)
Forces; moments, couples, statics of particles and rigid bodies in two and three dimensions; distributed forces—external and internal; first moments and centroids; analysis of structure-trusses, frames, and machines. *Prereq. 10.420 or 10.620, 11.417 or 11.617.*

02.612 Mechanics B (4 cl., 4 q.h.)
Friction, second moments, and virtual work; kinematics of particles-rectilinear and curvilinear motion of dynamic particles—force, mass and acceleration, work and energy. *Prereq. 02.411 or 02.611.*

02.613 Mechanics C (4 cl., 4 q.h.)
Impulse and momentum of particles; kinematics and dynamics of rigid bodies-force—mass, and acceleration; dynamics of rigid bodies—work and energy. Impulse and momentum; introduction to mechanical virbration. *Prereq. 02.412 or 02.612.*

02.614 Stress Analysis A (4 cl., 4 q.h.)
Axially loaded members; stress and strain, allowable stresses, factor of safety, temperature effects, indeterminate members; thin-walled pressure vessels; centric loading of bolted and welded connection. Shear and moment in beams; eccentrically loaded connections; flexural and transverse shearing stresses in beams. *Prereq. 02.411 or 02.611.*

02.615 Stress Analysis B (4 cl., 4 q.h.)
Determinate and indeterminate beam deflections and reactions by integration and area moment methods. Torsional stresses and strains; power transmission; eccentric loads on struts, beams, riveted and welded joints; combined stresses; principal stresses; Mohr's circle theories of failure. *Prereq. 02.414 or 02.614.*

02.616 Stress Analysis C (4 cl., 4 q.h.)
Curved beams; nonsymmetrical bending of beams; shear-center and shear stresses on thin sections; composite beams. Columns; energy absorption and resilience; inertial stresses, impact loading; deflection of beams by energy methods. Bolted fastenings. *Prereq. 02.415 or 02.615.*

02.619 Mechanics (4 cl., 4 q.h.)
A mechanics course for nonmechanical students. *Prereq. 10.420 or 10.620, 11.417 or 11.617.*

02.621 Thermodynamics A (4 cl., 4 q.h.)
General theory of heat and matter; laws of thermodynamics; energy-transformation principles and availability of energy; properties and processes for pure substances and ideal gases. Thermodynamic properties and processes of liquids and vapors; tables and charts; mixtures of fluids; vapor cycles. *Prereq. 11.418 or 11.618.*

02.622 Thermodynamics B (4 cl., 4 q.h.)
Theory of vapor engines and analysis of types of actual engines using compression of gases and vapors; internal combustion engines. Theory of gas and vapor flow through orifices and nozzles. Design and performance of steam and gas turbines; spark-ignition and compression-ignition engine design and performance. Fan performance. *Prereq. 02.421 or 02.621.*

02.623 Refrigeration & Air Conditioning (4 cl., 4 q.h.)
Air conditioning principles, including psychometrics and heat pumps. Calculation of heating and cooling loads in accordance with A.S.H.R.A.E. practices. Principles of gas compression; analysis of vapor compression; refrigeration systems; low-temperature refrigeration cycles; and absorption refrigeration systems. *Prereq. 02.422 or 02.622.*

02.630 Heat Transfer (4 cl., 4 q.h.)
The primary modes of heat transfer; thermal conductivity; thermal conductance/resistance concept; thermal-electrical analogy; combined heat transfer mechanisms, basic equations of conduction; analytical solutions of various steady state conduction problems. Dimensional analysis and similarity considerations; natural and forced convection; hydrodynamic and thermal boundary layers; black body radiation; Kirchhoff's law; emissivity and absorptivity; radiation between simple bodies; numerical methods. Log mean temperature differences; overall heat transfer coefficients; heat exchanger effectiveness; tubular exchanger design; regenerative and evaporative heat exchangers; heat transfer engineering problems. *Prereq. 02.422 or 02.622.*

02.631 Materials A (4 cl., 4 q.h.)
Lectures on: fundamental metallic structures; general metallurgical information covering theoretical aspects of properties; testing and failure of metals; supplemented by visual aids. Lectures on: alloying and hardening of metals; refinement of metals; equilibrium diagrams; characteristics of engineering metals; principles of metal fabrication.

02.632 Materials B (4 cl., 4 q.h.)
Lectures on: inorganic materials, i.e., polymers, glasses, ceramics, cements, wood, and materials having important electrical and magnetic properties; also a summary of the most up-to-date applications for the fabrication and uses of both metals and nonmetals. Structures of metals; imperfections; phase diagrams; effect of temperature on structure and properties of metals (annealing, recrystallization, recovery, precipitation, diffusion); strengthening mechanisms; mechanical properties of nonferrous metals.
Laboratory: experiments in preparation of samples, selection, polishing, and etching, examination of nonferrous metals; use of the microscope; linear analysis; construction of cooling curves; and simple binary phase diagrams. *Prereq. 02.431 or 02.631.*

02.633 Applied Metallurgy (4 cl., 4 q.h.)
Lectures on: mechanical properties of ferrous metals, the iron carbon diagram, high-temperature alloys, hardening methods, impact tests, effects of environment on metals;

manufacturing processes; methods of fabrication; limitations on the use of different materials and processes; casting, welding, cutting, drawing, powder metallurgy.
Laboratory: experiments on analysis of stress-drain diagrams of iron and steel, heat treatment of steels, surface corrosion, tempering and drawing, use of metallograph and analysis of the results. Experiments in cold rolling, swaging, drawing of nonferrous metals and the analysis of the results. Tension, shear, fatigue, and machinability tests on ferrous metals. *Prereq. 02.432 or 02.632.*

02.643 Fluid Mechanics A (4 cl., 4 q.h.)
Hydrostatics, principles governing fluids at rest; pressure measurement; hydrostatic forces on submerged areas and objects; simple dams; fluids in moving vessels; hoop tension. Fluid flow in pipes under pressure; fluid energy, power and friction loss; Bernoulli's Theorem; flow measurement. *Prereq. 02.412 or 02.612.*

02.644 Fluid Mechanics B (4 cl., 4 q.h.)
Pipe networks and reservoir systems; flow in open channels; uniform flow; energy, friction loss, minor losses, velocity distribution, alternate stages of flow, critical flow; nonuniform flow; accelerated and retarded flow; hydraulic jump and waves. *Prereq. 02.443 or 02.643.*

02.651 Mechanical Vibrations (4 cl., 4 q.h.)
Elements of vibrating systems, one degree of freedom (undamped free and forced vibration from Newton's law of motion and energy methods); natural frequencies; damped free and forced vibration; impedance and mobility, systems with more than one degree of freedom; influence coefficients. Lagrange's equations, generalized coordinates, vibration absorber. *Prereq. 02.413 or 02.613.*

02.652 Experimental Stress Analysis (4 cl., 4 q.h.)
Theory and experimentation showing the application of extensometers and electrical strain gauges as transducers in the field of experimental stress and strain analysis. Theory and laboratory practice on photoelastic methods as applied to classical model analysis and modern coating analysis. *Prereq. 02.415 or 02.615.*

02.673 Measurement & Analysis Laboratory (3 lab., 2 q.h.)
Experimental procedures for the collection and analysis of data by graphical and numerical methods, including computer applications, report writing that draws conclusions which are relative to accuracy, precision, true values, and measured values as they are related to basic mechanical measuring instruments for length, area, volume, specific gravity, pressure, temperature, and time as these parameters are utilized in making mechanical measurements. *Prereq. 02.414 or 02.614, 06.400 or 06.600, 10.422 or 10.622, 11.419 or 11.619.*

02.674 Technology Laboratory A (3 lab., 2 q.h.)
Experimental procedures to determine mechanical properties of materials under tensile, compressive, torsional, direct shear, flexural, impact, fatigue, and creep loading conditions as they are affected by environmental conditions that are normal and abnormal; also as they are affected by homogeneity, nonhomogeneity, isotropy, and nonisotropy.
Prereq. 02.473 or 02.673, 02.415 or 02.615, 02.431 or 02.631, or concurrently.

02.675 Technology Laboratory B (3 lab., 2 q.h.)
Experimental procedures to determine the physical properties of incompressible fluids, measure the flow rates and velocities utilizing pitot tubes, oriface plates, venturii meter,

and weirs flow meters, U tube differential manometers, and piezometers as the fluid flows through open channels, partially filled conduits, conduits under pressure, pipe networks, turbines, and pumps. *Prereq. 02.473 or 02.673, 02.443 or 02.643, or concurrently.*

02.676 Technology Laboratory C (3 lab., 2 q.h.)
Basic thermodynamic relationships; experimental procedures to examine the flow of compressible fluids and steam; examine the energy conversion of a fuel into a working substance and the related heat transfer mechanisms. Operating characteristics of thermal generators, engines, and compressors. *Prereq. 02.473 or 02.673, 02.422 or 02.622, or concurrently.*

02.677 Technology Laboratory D (3 lab., 2 q.h.)
Experimental procedures to examine the operating characteristics and efficiencies of internal combustion engines, brake horsepower, indicated horsepower, mean effective pressure, fuel consumption, torque, ignition timing, manifold pressure, and compression ratios and internal engines as energy conversion systems; energy conversion of fuels. *Prereq. 02.476 or 02.676, 02.422 or 02.622, 02.430 or 02.630, or concurrently.*

02.678 Technology Laboratory E (3 lab., 2 q.h.)
Experimental procedures of a project nature to examine refrigeration, air conditioning, and heating pump cycles. A project of analytical, design, or experimental nature. Experiments of advanced or specialized nature. *Prereq. 02.473 or 02.673, 02.423 or 02.623, 02.430 or 02.630.*

02.679 Power Generation (4 cl., 4 q.h.)
Basic power generation cycles; gas turbine cycles; effects of combustor temperature, intercooling, etc., on cycle performance; Rankine regenerative cycles; effects of steam temperature, pressure, number of feedwater heaters, etc., upon performance; steam generation equipment: boilers, reactors.
Fossil fuel characteristics and effects on boiler design; combustion analysis; draft calculations; axial and centrifugal fan performance characteristics; pump design and performance considerations; heat exchanger design considerations.
Applications of principles of economics to cycle and performance considerations; use of load curves; economic considerations of heat rate; economics of equipment selection; study of auxiliary equipment, such as precipitators and flue gas desulfurization systems. *Prereq. 02.422, 02.622, or 02.678.*

02.680 Mechanical Design A (4 cl., 4 q.h.)
Introduction to mechanical design, the design process, design factors, creativity, optimization, human factors, value engineering. These principles discussed and developed in an introductory manner through simple design projects.
Principles of design, properties and selection of materials; stress concentrations; strength under combined stresses; theories of failure; impact and fluctuating and repeated loads. *Prereq. 02.415 or 02.615 or 02.431 or 02.631.*

02.681 Mechanical Design B (4 cl., 4 q.h.)
Stresses; deformation and design of fasteners, screws, joints, springs, and bearings, lubrication and journal bearings.
Stresses and power transmission of spur, bevel, and worm gear; shaft design; clutches and brakes. *Prereq. 02.480 or 02.680.*

ELECTRICAL ENGINEERING TECHNOLOGY

03.301 Circuit Theory I (2 cl., 2 q.h.)
Ohm's law; Kirchhoff's current and voltage laws; equivalent resistances and sources; mesh and nodal analysis; network theorems; and power relations, all with respect to direct currents. *Prereq. 10.620, 11.619.*

03.302 Circuit Theory II (2 cl., 2 q.h.)
Energy storage; singularity functions; response of R, L, and C elements to singularities. *Prereq. 03.301, 10.621, or concurrently.*

03.303 Circuit Theory III (2 cl., 2 q.h.)
Complex algebra; phasors; frequency domain; mutual inductance; transformers; steady-state a-c theory; driving point and transfer impedances; power and energy in a-c circuits. *Prereq. 03.451 or 03.651.*

03.304 Circuit Theory IV (2 cl., 2 q.h.)
Laplace transforms; partial fraction expansion; Laplace transform techniques applied to the solution of RLC networks. *Prereq. 03.303.*

03.305 Circuit Theory V (2 cl., 2 q.h.)
Consideration of balanced and unbalanced polyphase power circuits; symmetrical components; harmonic analysis. *Prereq. 03.452 or 03.652.*

03.330 Microwave Measurements (2 cl., 2 q.h.)
A discussion of basic microwave measurement techniques, including continuous wave versus swept systems; analysis of detectors, insertion loss, attenuators, filters, return loss, couplers, insulators, amplifiers, audative devices. *Prereq. 03.429 or 03.629.*

03.341 Power and Controls Laboratory I (2½ lab., 2 q.h.)
These experiments introduce the student to standard laboratory measurement equipment, including voltmeter, ammeters, oscilloscopes, and frequency counters as well as data-taking methods and report writing. Devices investigated include diodes, bipolar transistors, field effect devices, silicon control rectifiers, unijunction transistor, power supplies, regulators, and various types of feedback transistor amplifiers. *Prereq. 03.430 or 03.630.*

03.342 Power and Controls Laboratory II (2½ lab., 2 q.h.)
Experiments with characteristics of DC motors and generators, single- and multiple-phase transformers, induction motors, synchronous motors, and 3-phase power measurements. *Prereq. 03.341.*

03.343 Power and Controls Laboratory III (2½ lab., 2 q.h.)
Experiments with self-synchronous devices such as control transformers, transmitters and receivers, AC and DC servomotors, open and closed loop response of servo mechanisms and stepping motors. *Prereq. 03.342.*

03.349 Advanced Electronics Laboratory IV (2½ lab., 2 q.h.)
Electronic engineering exercises selected from the following topics: transistor amplifier design, operational amplifiers, analog computation, Fourier optics, acoustics, and microwaves. *Prereq. 03.429 or 03.629.*

03.350 Advanced Electronics Laboratory V (2½ lab., 2 q.h.)
Design projects laboratory. Students will be directed in design of such projects as motor speed control, DC-DC converter, high-current pulse amplifiers, etc. *Prereq. 03.349.*

03.381 Linear Active Circuit Design I (2 cl., 2 q.h.)
Effects of feedback on impedance levels, frequency response, and distortion. Use of block diagram algebra and computation of transfer functions, frequency response. Stability of feedback circuits, Nyquist, Bode, and Nichols plots. Applications of Op-Amp circuits in integrators, differentiators, and active filters. *Prereq. 03.413 or 03.613.*

03.382 Linear Active Circuit Design II (2 cl., 2 q.h.)
Building blocks for multistage amplifiers. Analysis of differential amplifier stages, drifts, offset, CM rejection ratio. High-frequency behavior of transistors. Frequency response of multistage transistor amplifiers. Compensation techniques in feedback amplifiers. *Prereq. 03.381.*

03.383 Linear Active Circuit Design III (2 cl., 2 q.h.)
Applications of Op-Amps. Function generators, comparators, sample and hold D/A, A/D converters, oscillators, phase locked loops. Power amplifiers class A, B, AB, and C. Thermal analysis of power circuits. Switching amplifiers. *Prereq. 03.382.*

03.396 Basic Optics for Instrumentation (2 cl., 2 q.h.)
Provides the necessary background for the two instrumentation courses listed below. Includes basic topics in geometrical and physical optics. No previous background in optics is assumed. Topics included are: Gaussian optics, fundamental laws of image formation, basic elements of optical design, scalar wave theory, interference and diffraction, polarization, basics of coherent (laser) and noncoherent optics. *Prereq. 10.408 or 10.608 and 11.419 or 11.619.*

03.397 Optical Instrumentation I (2 cl., 2 q.h.)
Treats the classical image-forming instruments (telescopes, microscopes, etc.) as components of optical systems. Includes magnification, aberrations, resolution criteria, photometry, compatibility of system components, and optimization of systems. Topics in coherent imaging, such as phase contrast and holography. *Prereq. 03.396.*

03.398 Optical Instrumentation II (2 cl., 2 q.h.)
The basic nonimage-forming systems used for analysis control and metrology. Includes spectroscopy, interferometry (classical and holographic), electron-ion optical, and X-ray systems. *Prereq. 03.397.*

03.410 Electrical Measurements (4 cl., 4 q.h.) (Day Curriculum)
Standards of measurements, dimensional analysis, errors and measurement of dispersed data, discrete and continuous variables, binomial distribution, normal distribution, guaranteed error, methods of resistance measurements, digital voltmeters and analog to digital conversion, voltage references, potentiometers and a.c. bridges. *Prereq. 03.453 or 03.653.*

03.411 Electronics I (4 cl., 4 q.h.) (Day Curriculum)
Semiconductor diodes and applications, transistor biasing techniques, graphical analysis of basic amplifiers, d.c. and a.c. load lines. *Prereq. 03.452 or 03.652.*

03.412 Electronics II (4 cl., 4 q.h.) (Day Curriculum)
Small-signal, low-frequency transistor models, gains, and impedances at midband, frequency effects in transistor circuits, multistage circuits, transistors used as current sources. *Prereq. 03.411 or 03.611.*

03.413 Electronics III (4 cl., 4 q.h.) (Day Curriculum)
Review of Bode plots, transistor circuits at low and high frequencies, feedback, operational amplifiers, differential amplifiers, applications. *Prereq. 03.412 or 03.612.*

03.414 Pulse & Digital I (4 cl., 4 q.h.) (Day Curriculum)
Switching characteristics of semiconductor devices; wave generation and shaping, using combinations of passive and integrated circuit components; comparators, hysteresis, and the dual ramp analog to digital converter-voltmeter circuits; voltage to frequency conversion. *Prereq. 03.411 or 03.611.*

03.415 Pulse & Digital II (4 cl., 4 q.h.) (Day Curriculum)
Digital operations; logic statements and theorems; minimization of logic functions; logic gates and the characteristics of the integrated logic families; flip-flop counters and registers; introduction to sequential circuit design; sample and hold circuits; analog to digital conversion. *Prereq. 03.414 or 03.614.*

03.417 Principles of Communication Systems I (4 cl., 4 q.h.) (Day Curriculum)
Signal analysis using Fourier methods; noise in communication systems; frequency selective amplifiers including wideband; transistor power amplifiers AF and RF; oscillators; signal sources and applications. *Prereq. 03.413 or. 03.613.*

03.418 Principles of Communication Systems II (4 cl., 4 q.h.) (Day Curriculum)
Basic theory of amplitude, frequency, phase and pulse code modulated systems; analysis of modulating and demodulating circuits; carrier systems using SSB; system block and level diagrams; logic control circuits in communication systems; modems. *Prereq. 03.417 or 03.617.*

03.419 Principles of Communication Systems III (4 cl., 4 q.h.) (Day Curriculum)
Fundamentals of digital communications; sampling requirements; analog to digital conversion methods; system capacity and bandwidth; comparison of practical digital systems PAM, PCM, PFM, PWM; time and frequency division multiplexing; data decoding; selected examples from telemetry and computer links. *Prereq. 03.418 or 03.618.*

03.420 Electricity and Electronics I (4 cl., 4 q.h.) (Day Curriculum)
Introduction to circuit analysis, resistive networks, periodic excitation function, steady state a-c circuits; the physical foundations of electronics and the physical operation of electronic devices. (This course is not open to Electrical Engineering Technology majors.) *Prereq. 10.420 or 10.620, 11.419 or 11.619.*

03.421 Electricity and Electronics II (4 cl., 4 q.h.) (Day Curriculum)
Single-stage electronic circuits, magnetic circuits and transformers, electro mechanical energy conversion, d-c machines, a-c machines. (This course is not open to Electrical Engineering Technology majors.) *Prereq. 03.420 or 03.620.*

03.423 Electronics Laboratory (3 lab., 2 q.h.) (Day Curriculum)
Experiments dealing with laboratory equipment (meters and oscilloscopes) techniques; junction and field-effect transistor characteristics; vacuum and semiconductor diodes; power supplies, including the regulated type; silicon controlled rectifiers; resistance-coupled amplifiers using transistors, including feedback methods. *Prereq. 03.412 or 03.612, or concurrently.*

03.424 Circuits Laboratory I (3 lab., 2 q.h.) (Day Curriculum)
Experimentation in electronic circuit theory utilizing various measurement techniques. Instrumentation verification of circuit theorems; response of circuits to steps and impulses; oscilloscope theory and applications. *Prereq. 03.451 or 03.651.*

03.425 Circuits Laboratory II (3 lab., 2 q.h.) (Day Curriculum)
Further experimentation in electrical circuits and measurement techniques. Experiments include response of circuits to steps and impulses, nonlinear devices, terminal characteristics of active devices, log modulus plots, network parameters, and synthesis. Fourier analysis and synthesis. *Prereq. 03.424 or 03.624.*

03.427 Advanced Electronics Laboratory I (3 lab., 2 q.h.) (Day Curriculum)
Experiments dealing with the use of oscilloscopes, the examination of transistor audio amplifiers, push-pull amplifiers, drivers, pulse and video amplifiers, transients and wave-shaping circuits, audio frequency oscillators, and the study of operational amplifiers. *Prereq. 03.423 or 03.623.*

03.428 Advanced Electronics Laboratory II (3 lab., 2 q.h.) (Day Curriculum)
Experiments dealing with the modulation of a class C amplifier, the diode detector, basic timing circuits, RF and crystal oscillators, astable multivibrators, logic gates, flip-flops, binary adders, registers and counters; active filters, frequency modulation detectors, and analog-to-digital and digital-to-analog conversion. *Prereq. 03.427 or 03.627.*

03.429 Advanced Electronics Laboratory III (3 lab., 2 q.h.) (Day Curriculum)
Spectral studies of FM and PM waves, amplitude limiters; the balanced modulators and single sideband generators; integrated circuit timers and monolithic random access memory; monolithic phase-locked loop as well as a series of microwave experiments and a series of digital experiments. *Prereq. 03.428 or 03.628.*

03.430 Energy Conversion (4 cl., 4 q.h.) (Day Curriculum)
Generalized theory of rotating energy conversion devices; steady-state operation of the multiply-excited direct-current machine; control of speed; special machines; transformers; steady-state considerations of induction and synchronous machines; generalized machine and circuit model; Laplace transform techniques applied to the analysis of dynamic operating modes of rotating machines. *Prereq. 03.453 or 03.653 and 10.422 or 10.622.*

03.437 Distributed Systems (4 cl., 4 q.h.) (Day Curriculum)
Radiation, transmission, and reception of electromagnetic waves; distributed-line constants and traveling waves of transmission lines; differential equations of the uniform line. *Prereq. 10.422 or 10.622 and 11.419 or 11.619.*

03.451 Circuits Analysis I (4 cl., 4 q.h.) (Day Curriculum)
Ohm's law, Kirchhoff's current and voltage laws, equivalent resistances and sources, mesh and modal analysis, network theorems, two-port networks and power relations—

all with respect to direct currents; energy storage, singularity functions, response of R, L, and C elements to singularities. *Prereq. 10.420 or 10.620 and 11.419 or 11.619.*

03.452 Circuits Analysis II (4 cl., 4 q.h.) (Day Curriculum)
Complex algebra, phasors, frequency domain, mutual inductance, transformers, steady-stage a-c theory, driving point and transfer impedances, power and energy in a-c circuits; Laplace transforms; partial fraction expansion; Laplace transform techniques applied to the solution of RLC networks. *Prereq. 03.451 or 03.651.*

03.453 Circuits Analysis III (4 cl., 4 q.h.) (Day Curriculum)
Application of differential equations to the solutions of linear, time-invarient electrical networks; introduction to singularity functions, convolution, and time domain transient analysis; network topology and duality; introduction to the methods of transformation calculus and complex frequency concepts. *Prereq. 03.452 or 03.652.*

03.454 Circuits Analysis IV (4 cl., 4 q.h.) (Day Curriculum)
Signal analysis in the frequency domain; Fourier series; Fourier and Laplace transform methods; a varied selection of circuit problems is solved using Laplace transforms and related theorems. *Prereq. 03.453 or 03.653.*

03.460 Engineering Analysis I (4 cl., 4 q.h.) (Day Curriculum)
Linear algebra and its application to circuit equations; solution of linear differential equations including an introduction to Laplace transforms. *Prereq. 10.422 or 10.622 and 03.452 or 03.652.*

03.462 Basic Power Systems I (4 cl., 4 q.h.) (Day Curriculum)
Consideration of power transmission lines; line constants; current voltage and power relations; introduction to electric-power distribution loads, feeders, and substations; application of matrices. *Prereq. 03.454 or 03.654.*

03.463 Basic Power Systems II (4 cl., 4 q.h.) (Day Curriculum)
Consideration of symmetrical and unsymmetrical faults; protective devices—application and coordination; power flow in electric circuits; steady-state power limitations of systems; voltage regulation theory and application. *Prereq. 03.462 or 03.662.*

03.464 Basic Power Systems III (4 cl., 4 q.h.) (Day Curriculum)
Computer applications to power systems with emphasis on load-flow studies; basic ideas of systems planning, short-circuit studies and system stability. *Prereq. 03.463 or 03.663.*

03.470 Digital Computers (4 cl., 4 q.h.) (Day Curriculum)
Introduction to the field of digital computer design. Topics include general computer organization, number systems and number representations, design characteristics of major computer units, Boolean Algebra applications to computer design. *Prereq. 03.411 or 03.611.*

03.471 Digital Computers II (4 cl., 4 q.h.) (Day Curriculum)
Examination of microprocessor architecture and organization. Study of the machine language and assembly coding of an industry-accepted microprocessor. A suitable topic

selected from the current literature by the instructor will be analyzed. Assembly language coding problems will be assigned. *Prereq. 03.470 or 03.670.*

03.477 Control Engineering I (4 cl., 4 q.h.) (Day Curriculum)
Analysis of linear servomechanisms under both transient and steady-state conditions; signal flow graphs; Laplace transforms used in the formulation of block diagrams and transfer function. *Prereq. 03.454 or 03.654 and 10.422 or 10.622.*

03.478 Control Engineering II (4 cl., 4 q.h.) (Day Curriculum)
System stability; root locus techniques; treatment of Nyquist criteria and Bode diagram methods for systems evaluation. *Prereq. 03.477 or 03.677.*

03.490 Optical Instrumentation (4 cl., 4 q.h.) (Day Curriculum)
Telescopes, microscopes, etc., as optical system components. Includes magnification, aberrations, resolution criteria, photometry. Compatibility of system components and optimization of systems. The basic nonimage-forming systems used for analysis control and metrology. *Prereq. 10.408 or 10.608 and 11.419 or 11.619.*

03.498 Special Problems In Electrical Engineering Technology (2 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

03.499 Special Problems in Electrical Engineering Technology (4 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

03.531 Digital Signal Processing 1 (2 cl., 2 q.h.)
Introduction to digital signal processing discussing sampling, transform and discrete Fourier transform. *Prereq. 03.454 or 03.654 and 06.400 or 06.600.*

03.532 Digital Signal Processing 2 (2 cl., 2 q.h.)
Discrete systems are taken up with a comparison of continuous and digital filter design. *Prereq. 03.531.*

03.533 Digital Signal Processing 3 (2 cl., 2 q.h.)
Frequency domain design is covered with linear phase FIR filters, fast Fourier transforms, continuing with convolution and correlation. *Prereq. 03.352.*

03.598 Special Problems in Electrical Engineering Technology (2 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

03.599 Special Problems in Electrical Engineering Technology (4 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

03.610 Electrical Measurements (4 cl., 4 q.h.)
Standards of measurements, dimensional analysis, errors and measurement of dispersed data, discrete and continuous variables, binomial distribution, normal distribution, guaranteed error, methods of resistance measurements, digital voltmeters and analog to

digital conversion, voltage references, potentiometers and a.c. bridges. *Prereq. 03.453 or 03.653.*

03.611 Electronics I (4 cl., 4 q.h.)
Semiconductor diodes and applications, transistor biasing techniques, graphical analysis of basic amplifiers, d.c. and a.c. load lines. *Prereq. 03.452 or 03.652.*

03.612 Electronics II (4 cl., 4 q.h.)
Small-signal, low-frequency transistor models, gains and impedances at midband, frequency effects in transistor circuits, multistage circuits, transistors used as current sources. *Prereq. 03.411 or 03.611.*

03.613 Electronics III (4 cl., 4 q.h.)
Review of Bode plots, transistor circuits at low and high frequencies, feedback, operational amplifiers, differential amplifiers, applications. *Prereq. 03.412 or 03.612.*

03.614 Pulse & Digital I (4 cl., 4 q.h.)
Switching characteristics of semiconductor devices; wave generation and shaping using combinations of passive and integrated circuit components; comparators, hysteresis, and the dual ramp analog to digital converter-voltmeter circuits; voltage to frequency conversion. *Prereq. 03.411 or 03.611.*

03.615 Pulse & Digital II (4 cl., 4 q.h.)
Digital operations; logic statements and theorems; minimization of logic functions; logic gates and the characteristics of the integrated logic families; flip-flop counters and registers; introduction to sequential circuit design; sample and hold circuits; analog to digital conversion. *Prereq. 03.414 or 03.614.*

03.617 Principles of Communication Systems I (4 cl., 4 q.h.)
Signal analysis using Fourier methods; noise in communication systems; frequency selective amplifiers, including wideband; transistor power amplifiers AF and RF; oscillators; signal sources, and applications. *Prereq. 03.613 or 03.413.*

03.618 Principles of Communication Systems II (4 cl., 4 q.h.)
Basic theory of amplitude, frequency, phase and pulse code modulated systems; analysis of modulating and demodulating circuits; carrier systems using SSB; system block and level diagrams; logic control circuits in communication systems; modems. *Prereq. 03.417 or 03.617.*

03.619 Principles of Communication Systems III (4 cl., 4 q.h.)
Fundamentals of digital communications; sampling requirements; analog to digital conversion methods; system capacity and bandwidth; comparison of practical digital systems PAM, PCM, PFM, PWM; time and frequency division multiplexing; data decoding; selected examples from telemetry and computer links. *Prereq. 03.618 or 03.418.*

03.620 Electricity and Electronics I (4 cl., 4 q.h.)
Introduction to circuit analysis, resistive networks, periodic excitation function, steady state a-c circuits; the physical foundations of electronics and the physical operation of electronic devices. (This course is not open to Electrical Engineering Technology majors.) *Prereq. 10.620 or 10.420 and 11.619 or 11.419.*

03.621 Electricity and Electronics II (4 cl., 4 q.h.)
Single-stage electronic circuits, magnetic circuits and transformers, electro-mechanical energy conversion, d-c machines, a-c machines. (This course is not open to Electrical Engineering Technology majors.) *Prereq. 03.620 or 03.420.*

03.623 Electronics Laboratory (3 lab., 2 q.h.)
Experiments dealing with laboratory equipment (meters and oscilloscopes) techniques; junction and field-effect transistor characteristics; vacuum and semiconductor diodes; power supplies, including the regulated type; silicon controlled rectifiers; resistance-coupled amplifiers using transistors, including feedback methods. *Prereq. 03.612 or 03.412, or concurrently.*

03.624 Circuits Laboratory I (3 lab., 2 q.h.)
Experimentation in electronic circuit theory utilizing various measurement techniques. Instrumentation verification of circuit theorems; response of circuits to steps and impulses; oscilloscope theory and applications. *Prereq. 03.651 or 03.451.*

03.625 Circuits Laboratory II (3 lab., 2 q.h.)
Further experimentation in electrical circuits and measurement techniques. Experiments include response of circuits to steps and impulses, nonlinear devices, terminal characteristics of active devices, log modulus plots, network parameters and synthesis. Fourier analysis and synthesis. *Prereq. 03.624 or 03.424.*

03.627 Advanced Electronics Laboratory I (3 lab., 2 q.h.)
Experiments dealing with the use of oscilloscopes, the examination of transistor audio amplifiers, push-pull amplifiers, drivers, pulse and video amplifiers, transients and wave-shaping circuits, audio frequency oscillators, and the study of operational amplifiers. *Prereq. 03.623 or 03.423.*

03.628 Advanced Electronics Laboratory II (3 lab., 2 q.h.)
Experiments dealing with the modulation of a class C amplifier, the diode detector, basic timing circuits, RF and crystal oscillators, astable multivibrators, logic gates, flip-flops, binary adders, registers and counters; active filters, frequency modulation detectors, and analog-to-digital and digital-to-analog conversion. *Prereq. 03.627 or 03.427.*

03.629 Advanced Electronics Laboratory III (3 lab., 2 q.h.)
Spectral studies of FM and PM waves, amplitude limiters; the balanced modulators and single sideband generators; integrated circuit timers and monolithic random access memory; monolithic phase-locked loop as well as a series of microwave experiments and a series of digital experiments. *Prereq. 03.628 or 03.428.*

03.630 Energy Conversion (4 cl., 4 q.h.)
Generalized theory of rotating energy conversion devices; steady-state operation of the multiply-excited direct-current machine; control of speed; special machines; transformers; steady-state considerations of induction and synchronous machines; generalized machine and circuit model; Laplace transform techniques applied to the analysis of dynamic operating modes of rotating machines. *Prereq. 03.653 or 03.453 and 10.622 or 10.422.*

03.637 Distributed Systems (4 cl., 4 q.h.)
Radiation, transmission, and reception of electromagnetic waves; distributed-line constants and traveling waves of transmission lines; differential equations of the uniform line. *Prereq. 10.622 or 10.422 and 11.619 or 11.419.*

03.651 Circuits Analysis I (4 cl., 4 q.h.)
Ohm's law, Kirchhoff's current and voltage laws, equivalent resistances and sources, mesh and modal analysis, network theorems, two-port networks and power relations—all with respect to direct currents; energy storage, singularity functions, responses of R, L, and C elements to singularities. *Prereq. 10.620 or 10.420 and 11.619 or 11.419.*

03.652 Circuits Analysis II (4 cl., 4 q.h.)
Complex algebra, phasors, frequency domain , mutual inductance, transformers, steady-stage a-c theory, driving point and transfer impedances, power and energy in a-c circuits; Laplace transforms; partial fraction expansion; Laplace transform techniques applied to the solution of RLC networks. *Prereq. 03.651 or 03.451.*

03.653 Circuits Analysis III (4 cl., 4 q.h.)
Application of differential equations to the solutions of linear, time-invarient electrical networks; introduction to singularity functions, convolution, and time domain transient analysis; network topology and duality; introduction to the methods of transformation calculus and complex frequency concepts. *Prereq. 03.652 or 03.452.*

03.654 Circuits Analysis IV (4 cl., 4 q.h.)
Signal analysis in the frequency domain; Fourier series; Fourier and Laplace transform methods; a varied selection of circuit problems is solved using Laplace transforms and related theorems. *Prereq. 03.653 or 03.453.*

03.662 Basic Power Systems I (4 cl., 4 q.h.)
Consideration of power transmission lines; line constants; current voltage and power relations; introduction to electric-power distribution loads, feeders, and substations; application of matrices. *Prereq. 03.654 or 03.454.*

03.663 Basic Power Systems II (4 cl., 4 q.h.)
Consideration of symmetrical and unsymmetrical faults; protective devices—application and coordination; power flow in electric circuits; steady-state power limitations of systems; voltage regulation theory and application. *Prereq. 03.662 or 03.462.*

03.664 Basic Power Systems III (4 cl., 4 q.h.)
Computer applications to power systems with emphasis on load-flow studies; basic ideas of systems planning, short-circuit studies and system stability. *Prereq. 03.663 or 03.463.*

03.670 Digital Computers I (4 cl., 4 q.h.)
Introduction to the field of digital computer design. Topics include general computer organization, number systems and number representations, design characteristics of major computer units. Boolean Algebra applications to computer design. *Prereq. 03.611 or 03.411.*

03.671 Digital Computers II (4 cl., 4 q.h.)
Examination of microprocessor architecture and organization. Study of the machine language and assembly coding of an industry-accepted microprocessor. A suitable topic selected from the current literature by the instructor will be analyzed. Assembly language coding problems will be assigned. *Prereq. 03.670 or 03.470.*

03.677 Control Engineering I (4 cl., 4 q.h.)
Analysis of linear servomechanisms under both transient and steady-state conditions; signal flow graphs; Laplace transforms used in the formulation of block diagrams and transfer function. *Prereq. 03.654 or 03.454 and 10.622 or 10.422.*

03.678 Control Engineering II (4 cl., 4 q.h.)
System stability; root locus techniques; treatment of Nyquist criteria and Bode diagram methods for systems evaluation. *Prereq. 03.677 or 03.477.*

03.690 Optical Instrumentation (4 cl., 4 q.h.)
Telescopes, microscopes, etc., as optical system components. Includes magnification, aberrations, resolution criteria, photometry. Compatibility of system components and optimization of systems. The basic nonimage-forming systems used for analysis control and metrology. *Prereq. 10.608 or 10.408 and 11.619 or 11.419.*

CHEMICAL ENGINEERING TECHNOLOGY

04.381 Nuclear Technology I (2 cl., 2 q.h.)
Atomic and nuclear structure; discovery and nature of radioactivity; nuclear instrumentation for particle detection, monitoring, and experimentation; supplementary laboratory experiments. *Prereq. 10.623, 11.619.*

04.382 Nuclear Technology II (2 cl., 2 q.h.)
Nuclear reactions and energy; induced nuclear transformations; neutron properties; radiological safety—the hazards, problems, and protection; applications of radionuclides; supplementary laboratory experiments. *Prereq. 04.381.*

04.383 Nuclear Technology III (2 cl., 2 q.h.)
The fission process and its applications; nuclear reactors—their classification, design, and application; nuclear fuel processing; radioactive waste disposal; supplementary laboratory experiments. *Prereq. 04.382.*

04.481 Nuclear Technology (4 cl., 4 q.h.) (Day Curriculum)
Atomic and nuclear structure; discovery and nature of radioactivity; nuclear reactions and energy; induced nuclear transformation; neutron properties; nuclear instrumentation for particle detection, monitoring, and experimentation; the fission process and its applications; nuclear reactors—their classification, design, and application; supplementary laboratory experiments. *Prereq. 10.422, 11.619.*

INDUSTRIAL ENGINEERING TECHNOLOGY

05.660 Engineering Economy I (4 cl., 4 q.h.)
Fundamental accounting concepts and familiarization with terminology. Assets, liability, net worth. Analysis of income statement and balance sheet. Flow of funds in a firm. Sources of capital-equity, borrowed, retained earnings, depreciation and depreciation accounting, taxes. Cost of capital, time value of money, equivalence, cash flow of diagrams and tables. Development of cash flows for alternative capital expenditures, analytical methods of engineering economy, including present worth, annual cost, and rate of return. Incremental rate of return, breakeven analysis. Retirement and replacement.

05.582 Industrial Technology I (2 cl., 2 q.h.)
Concepts of methods analysis and work simplification, use of man-machine charts, principles of motion economy, human considerations in designing man-machine systems.

05.583 Industrial Technology II (2 cl., 2 q.h.)
Work measurement, techniques of measurement to include stop watch, micromotion, memomotion, work sampling and predetermined systems. Development of standard data. Establishment of standards, fatigue and delay allowances, rating techniques, incentive plans. *Prereq. 05.582.*

05.590 Engineering Probability and Statistics I (2 cl., 2 q.h.)
Algebra of events and sets. Probability measure, laws of probability. Independence, conditional probability. Random variables, discrete and continuous. Properties of random variables, including density functions, expectations, variance. *Prereq. 10.323.*

05.591 Engineering Probability and Statistics II (2 cl., 2 q.h.)
Sampling statistics. Estimation of parameters of random variables. Point and interval estimation. Hypothesis testing. Simple and composite hypothesis. One-sided and two-sided tests. Tests of measures of variances. Normal, standard deviation, F, X^2. *Prereq. 05.590.*

COMPUTER TECHNOLOGY

09.400 Computer Programming for Engineering Technology (4 cl., 4 q.h.)
(Day Curriculum)
Introduction to the use of computers in the solution of problems using FORTRAN on interactive terminals. Students write and run programs to compute sequences, averages, etc. Other capabilities of the FORTRAN language, including DO loops, subscripted variables, and alphanumeric manipulation, matrix algebra, and numerical methods. *Prereq. 10.408 or concurrently.*

09.600 Computer Programming for Engineering Technology (4 cl., 4 q.h.)
Introduction to the use of computers in the solution of problems using FORTRAN on interactive terminals. Students write and run programs to compute sequences, averages, etc. Other capabilities of the FORTRAN language, including DO loops, subscripted variables, and alphanumeric manipulation, matrix algebra, and numerical methods. *Prereq. 10.608 or concurrently.*

09.601 FORTRAN Engineering Computation (4 cl., 4 q.h.)
Professional methods for solving engineering problems with FORTRAN. Students will write and run programs using the University's computer. Topics include: subprograms, scientific software packages, solution of equations, data storage, reduction and display. *Prereq. 09.600 or 09.353.*

09.605 Introduction to Programming (4 cl., 4 q.h.)
A high-level structured language will be taught and used as a vehicle for implementing programs. Students will write and run programs using N.U.'s computer. Topics: using

---

Note: Students at suburban campuses will find it necessary periodically to come to the Boston Campus Computation Center to run their homework problems.

N.U.'s computer, flow charting, program construction, computations involving maxima and minima, arrays, simple recursion, subroutines.

09.610 FORTRAN (4 cl., 4 q.h.)
This important scientific language will be taught with engineering applications. Students will write and run FORTRAN programs using N.U.'s computer. Topics: arithmetic replacement, input, output, control and specification statements, looping, arrays, functions and subroutines. *Prereq. 09.605 or equiv.*

09.615 Pascal (A Second Language) (4 cl., 4 q.h.)
An introductory course in programming computers using the Pascal language. Students will write and run programs using the University's computer facilities. This course may not be used as a technical elective in the Computer Technology Program. *Prereq. 06.600 or equivalent.*

09.620 COBOL (4 cl., 4 q.h.)
This important business language will be taught with general applications. Students will write and run COBOL programs using N.U.'s computer. Topics: divisions, names, rules, picture clauses, verbs, input/output instructions, levels, working storage, arithmetic, corresponding, accept, display, compute, copy, update logic, table logic, redefines, search, inline, and COBOL sorts. *Prereq. 09.605 or equiv.*

09.630 Nonnumerical Algorithms (4 cl., 4 q.h.)
Data; structures, storage, manipulation, and retrieval methods. Students will write and run data manipulation programs using N.U.'s computer. Topics: stacks, queues, lists, trees, heaps, sets, graphs, hashing, searching, sorting, key processing, relational models. *Prereq. 09.605.*

09.635 Numerical Algorithms (4 cl., 4 q.h.)
Computer methods for solving mathematical problems. Students will write and run application programs using N.U.'s computer. Topics: deterministic vs. stochastic methods, random number generators, iterative vs. noniterative solutions, maxima and minima in 2 and 3 variables, curve fitting in 2 and 3 variables, integrals, trapezoidal and Simpsons rules, slopes, difference equations in 2 and 3 variables, vector and matrix algebra, simultaneous linear equations, nonlinear equations, permutations, and combinations. *Prereq. 09.610 or equiv.*

09.640 Modern Programming Techniques (4 cl., 4 q.h.)
Structured methods for developing complex computer programs. Students will develop and write sections of complex programs. Students will run programs on N.U.'s computer. Topics: top down design, hierarchy diagrams, HIPO charts, composite design, structured analysis, team programming. *Prereq. 09.605.*

09.645 Assembly Language (4 cl., 4 q.h.)
A typical microprocessor assembly language will be taught. Students will write and run homework problems using a microprocessor simulator package implemented on N.U.'s computer. Topics: binary arithmetic, instruction sets, addressing modes, code conversion, subroutines, macros, I/O. *Prereq. 09.605.*

09.650 Basic Computer Organization (4 cl., 4 q.h.)
Fundamental aspects of basic computer components. Topics: the functions and general operating characteristics of CPU's, primary/secondary and mass memory, controllers,

printers card readers terminals. What an operating system does, scheduling, monitoring, spooling, paging, system programs, virtual memory, multiprogramming, multiprocessing. *Prereq. 09.605.*

09.651 Advanced Computer Organization (4 cl., 4 q.h.)
The operating and performance characteristics of complex and special purpose components. Topics: how an operating system works, memory hierarchies, fiber optics, bubble memory, mass storage, computer networks, distributed processing, data flow, cache memory, associative memory, special purpose/parallel processors, system performance measures. *Prereq. 09.605.*

09.655 Micro Peripheral Hardware (4 cl., 4 q.h.)
The elements of microprocessor peripheral hardware and its interfacing. Students will configure microprocessor systems, using block diagrams showing relevant handshaking signals. Topics: serial and parallel I/O devices, DMA and interrupt control devices, bus arbitration, memory management units, counter timers as extensions of basic CPU functions. *Prereq. 09.675.*

09.656 Complex Peripheral Hardware (4 cl., 4 q.h.)
The interfacing and implementation of special purpose hardware. Students will configure systems, using block diagrams showing relevant handshaking signals. Topics: virtual memory, rotating media, printers, terminals, bus extension concepts, co-processors. *Prereq. 09.655.*

09.660 Industry Software (4 cl., 4 q.h.)
A survey of current commercial software packages and methods. Students will exercise commercial packages implemented on N.U.'s computer where applicable. Topics: specific packages and methods which vary from year to year to maintain currency. They will be drawn from the following general categories: data base management, scientific and statistical analysis, security and privacy, software assurance, and documentation. *Prereq. 09.651, 09.610.*

09.665 Industry Hardware (4 cl., 4 q.h.)
A survey of the latest industrial developments and trends in computer hardware. Conducted as a seminar. *Prereq. 09.656.*

09.668 Semiconductor Logic (4 cl., 4 q.h.)
A detailed analysis of the bipolar and MOS transistors in saturated and cutoff conditions. Implementation of these concepts to form basic logic and decision-making circuits. Students will convert logical expressions into hardware configuration representations. Topics: Ebers-Moll modeling, PMOS, NMOS, CMOS construction, logic families. *Prereq. 03.652.*

09.669 Computer Logic (4 cl., 4 q.h.)
An introduction to the hardware building blocks of general computers. Students will specify configurations of lower level components to achieve composite logical functions, e.g., construct a register from NAND gates. Topics: gates, flipflops, registers, decoders, ALU's, memory arrays. *Prereq. 09.668.*

09.674 Introduction to CPU Hardware (4 cl., 4 q.h.)
The internal operation of a microprocessor CPU. A black box approach is used. Students purchase and keep individual single board computers for doing homework and simulation.

Topics: registers and timing control, programmable gate arrays, array processors as CPU models. *Prereq. 09.645 or equiv.*

09.675 CPU Hardware Architecture (4 cl., 4 q.h.)
The performance characteristics of commercially available CPU's. Students will write code for 4 bit through 32 bit processors. Topics: the characteristics of 4004, 4008, 8080, Z80, Z8000, 8086, 1802, F8, and 6800 processors, and how to use one processor in place of another. Note: the list of processors examined may vary from year to year to maintain currency. *Prereq. 09.674.*

09.680 Data Communication Methods (4 cl., 4 q.h.)
Functional and operational aspects of data communication devices and software. A black box approach will be used. Topics: modems, control units, multiplexers, concentrators, front end processors, synchronous/asynchronous/half duplex/full duplex codes and procedures, Bisynch/SDLE/HDLC, BYTE and BIT protocols, error checking, point to point/multidrop/STAR/MESH/CLUSTER networks. *Prereq. 09.610.*

09.681 Operating Systems (4 cl., 4 q.h.)
The basic principles of operating system implementation. Students write and run programs to exercise elements of the University's operating system when applicable. Topics: resource, memory, processor and device management commands and strategies, I/O programming, swapping, overlays, jobs and process scheduling, and other operating systems. *Prereq. 09.651.*

09.682 Computer Graphics Programming (4 cl., 4 q.h.)
Students are introduced to generalized techniques for the computer plotting of 2 and 3 dimensional shapes. Students write and run programs using the University's computer and digital plotter. Topics: 2D transforms, 3D to 2D transforms, 3D transforms, surface representation, shading, characters, curve fitting, graphic data structures. *Prereq. 09.610.*

09.683 Data Bases (4 cl., 4 q.h.)
An introduction to data base organization structure and management. Students write and run programs exemplifying techniques developed in class on the University's computer. Topics: access methods, attributes, indices, keys, querying, searching and matching, file sets, inverted file sets, normal forms, random access. *Prereq. 09.630.*

09.684 Large System Assembly Languages (4 cl., 4 q.h.)
Typical large computer system assembly languages. Students will write and run illustrative programs on the University's computer. Topics: edit and translate instructions, macro writing, program sectioning, linking, data representation, addressing, instruction formats in BAL and VAX-11 assembler languages. *Prereq. 09.645.*

09.685 Introduction to Simulation Programming (4 cl., 4 q.h.)
Computer methods for solving simulated phenomena. Students will write and run programs implementing simulations specified by instructor. Students will not be responsible for the validity or evaluation of models except in simple cases. Topics: simple queues, multiserver queues, priorities including first in first out, last in last out, and time aging of data, simple frequency distributions, use of SIMULA, GPSS, and Standard Subroutine Library Routines. *Prereq. 09.635.*

09.686 Device System Hardware (4 cl., 4 q.h.)
A study of the principal hardware capabilities and current trends in micro computer level systems. Included are both single users and network-oriented systems. *Prereq. 09.675.*

09.687 Bit Slice Micro Computers (4 cl., 4 q.h.)
The epitome of hardware flexibility is represented by the bit slice CPU. Demonstrates the basic design ground rules common to this style of hardware design. *Prereq. 09.655.*

09.688 Micro Controllers (4 cl., 4 q.h.)
The commercial segment of micro computers has been satisfied by a variety of single chip 4 bit micros controllers. A detailed contrast/comparison will be done on several of these devices, including the IMS-1000, S2000, COPS, and PPS-4. *Prereq. 09.674.*

09.689 Single Chip Microprocessors (4 cl., 4 q.h.)
When small 8 bit intelligent devices are rewired in high volume, the single chip microprocessor in the form of the 3870, 8048, Z8, and others comes into play. An understanding of the hardware limitations of a single chip system presents the basis for this subject material. *Prereq. 09.674.*

09.690 Special Problems in Computer Technology (4 cl., 4 q.h.)
Theoretical or experimental work under individual faculty supervision. *Prereq. Consent of department chairperson.*

ENGINEERING GRAPHICS

09.464 Engineering Design Graphics IV (4 cl., 4 q.h.) (Day Curriculum)
Graphical analysis of kinematic elements; displacement, locus generators, velocity vectors, and sliding motion; simple, compound, and reverted gear trains; acceleration analysis of mechanisms such as cams and linkages; functions, scales and nomographs; introduction to self-correcting (feedback) systems. *Prereq. 09.471.*

09.470 Engineering Graphics I (4 cl., 4 q.h.) (Day Curriculum)
The study of concepts and the development of skills to present and to analyze objects and systems used in design through the principles of graphical geometric constructions, orthographic projections (multi-view, two-dimensional drawings), and the design process. Assignments will include the layout of drawings on the paper, solutions to graphical problems concerning objects and systems, and complete solutions to short problems using the design process.

09.471 Engineering Graphics II (4 cl., 4 q.h.) (Day Curriculum)
Continuation of the study of concepts and the development of skills to present and to analyze objects and systems used in design, including dimensioning, sectioning, threads, fasteners, assembly and detail drawings, as well as the design process. Assignments will require solutions to graphical problems that will require the studied graphical material and a progress report leading to the solution of a design problem. *Prereq. 09.470.*

09.472 Electrical Engineering Graphics (4 cl., 4 q.h.) (Day Curriculum)
Introduction to electronic graphics, including symbols, schematics, block and logic diagrams, production and cable drawings, military standards. A study of single- and double-

sided printed circuit layout, integrated circuits, electro-mechanical designs, wiring, and interconnection diagrams; graphical data presentation. *Prereq. 09.470.*

09.664 Engineering Design Graphics IV (4 cl., 4 q.h.)
Graphical analysis of kinematic elements; displacement, locus generators, velocity vectors, and sliding motion; simple, compound, and reverted gear trains; acceleration analysis of mechanisms such as cams and linkages; functions, scales and nomographs; introduction to self-correcting (feedback) systems. *Prereq. 09.671.*

09.670 Engineering Graphics I (4 cl., 4 q.h.)
Introduction to engineering drawing by geometric constructions, charting, and graphs. Orthographic projection, including reading, sketching, and auxiliary views. Axonometric drawing and elements of descriptive geometry. Section and conventions.

09.671 Engineering Graphics II (4 cl., 4 q.h.)
Determination of design project. Intersections and development. Manufacturing processes and dimensioning, including true position tolerancing. Threads and fasteners. Making and reading assembly drawing. Topographical and earth work drawings as applicable to civil engineers. Case studies of engineering problems and introduction to computer-aided design. Presentation of design project. *Prereq. 09.611.*

09.672 Electrical Engineering Graphics (4 cl., 4 q.h.)
Introduction to electronic graphics, including symbols, schematics, block and logic diagrams, production and cable drawings, military standards. A study of single- and double-sided printed circuit layout, integrated circuits, electro-mechanical designs, wiring, and interconnection diagrams; graphical data presentation. *Prereq. 09.670.*

MATHEMATICS

10.316 Probability and Statistics I (2 cl., 2 q.h.)
(appropriate for both engineering and non-engineering students)
Basic tools, e.g., sets, permutations and combinations; probability and its applications; discrete and continuous random variables. *Prereq. 10.308.*

10.317 Probability and Statistics II (2 cl., 2 q.h.)
Frequency distributions and probability density functions; binomial, normal, and other distributions; central limit theorem; hypothesis testing; analysis of variance; correlation; statistical inference and estimation. Examples taken from many different fields. *Prereq. 10.316.*

10.318 Probability and Statistics III (2 cl., 2 q.h.)
Contingency tables; simple linear regression; multiple regression; model building. *Prereq. 10.317.*

10.324 Differential Equations I (2 cl., 2 q.h.)
Ordinary differential equations—standard types of the first order; some applications; special differential equations of the second order. *Prereq. 10.323.*

10.325 Differential Equations II (2 cl., 2 q.h.)
Linear differential equations with constant coefficients, homogeneous and nonhomogeneous; variation of parameters, simultaneous differential equations; Laplace transform. *Prereq. 10.324.*

10.326 Differential Equations III (2 cl., 2 q.h.)
Continuation of Laplace transform; series and solution of differential equations by series; Fourier series; orthogonal functions. *Prereq. 10.325.*

10.351 Advanced Mathematics I (Numerical Analysis) (2 cl., 2 q.h.)
Basic methods of numerical analysis—roots by iteration; approximating polynomials and interpolation; least squares fitting; numerical integration; approximate solution of ordinary differential equations—problems employing the electronic computer. *Prereq. 06.601 or 06.610 and 10.623.*

10.352 Advanced Mathematics II (2 cl., 2 q.h.)
Introduction to partial differential equations, boundary-value problems, Sturm-Liouville systems. *Prereq. 10.351.*

10.353 Advanced Mathematics III
Special topics in analysis. *Prereq. 10.352.*

10.361 Modern Algebra I (2 cl., 2 q.h.)
Sets; binary operations; mappings; rings, integers, fields; reals, bases for computer applications; Euclidean algorithm; primes. *Prereq. 10.608, 10.329, or 10.335.*

10.362 Modern Algebra II (2 cl., 2 q.h.)
Field of complex numbers; groups; subgroups; polynomial rings; homomorphisms; isomorphisms, ideals. *Prereq. 10.361.*

10.363 Modern Algebra III (2 cl., 2 q.h.)
Vector spaces; linear transformations; dependence, independence; dimension applications to engineering, science, and business. *Prereq. 10.362.*

10.364 Modern Applied Algebra (4 cl., 4 q.h.)
Introduction to the language of abstract algebra to the following topics: graphs, finite state machines, programming languages, Boolean Algebra, lattices, coding for communication channels, and radar; look at algebraic theory of linear systems. *Prereq. 10.361, 10.362, and 10.363.*

10.404 Pre-Calculus Mathematics (4 cl., 4 q.h.) (Summer Quarter only)
Treats those topics in algebra, trigonometry, and analytical geometry which will be of greatest value to the beginning calculus student.

10.407 College Algebra and Trigonometry I (4 cl., 4 q.h.) (Day Curriculum)
Fundamental algebraic operations; complex numbers; radicals and exponents; functions; linear and quadratic equations; irrational equations; inequalities; variation; roots of polynomial equations.

10.408 College Algebra and Trigonometry II (4 cl., 4 q.h.) (Day Curriculum)
Logarithms; trigonometric functions of angles in degrees and radians; trigonometric identities and equations; right triangles; oblique triangles; complex numbers in trigonometric form; systems of equations; determinants. *Prereq. 10.407 or 10.607.*

10.420 Calculus I (4 cl., 4 q.h.) (Day Curriculum)
Plane analytic geometry; differentiation of algebraic functions; rate, motion, maximum and minimum problems; derivations of higher order; curve sketching; basics in functions, limits, and continuity. *Prereq. 10.408 or 10.608.*

10.421 Calculus—A (4 cl., 4 q.h.) (Day Curriculum)
Applications of derivatives to curvesketching; antidifferentiation; the definite integral, with applications; calculus of nonalgebraic functions—logarithmic, exponential, and trigonometric; calculus of inverse trigonometric functions; techniques of integration; indeterminate forms; L'Hospital's rule. *Prereq. 10.420 or 10.620.*

10.422 Calculus—B (3 cl., 4 q.h.) (Day Curriculum)
Calculus of functions of several variables; partial differentiation; multiple integrals; infinite series; vector analysis; polar coordinates; vectors in a plane. *Prereq. 10.421 or 10.621.*

10.423 Differential Equations (4 cl., 4 q.h.) (Day Curriculum)
Ordinary differential equations—standard types of the first order; linear differential equations, especially with constant coefficients; Laplace transforms; series solutions of differential equations; Fourier series; and orthogonal functions. *Prereq. 10.422 or 10.622.*

10.607 College Algebra I (4 cl., 4 q.h.)
Fundamental algebraic operations; complex numbers; radicals and exponents; functions; linear and quadratic equations; irrational equations; inequalities; variation; roots of polynomial equations. *Prereq. Math Placement Test or 10.682.*

10.608 Introduction to Calculus (4 cl., 4 q.h.)
Logarithms; trigonometric functions of angles in degrees and radians; trigonometric identities and equations; right triangles; oblique triangles; complex numbers in trigonometric form; systems of equations; determinants. *Prereq. 10.407 or 10.607.*

10.620 Calculus I (4 cl., 4 q.h.)
Plane analytic geometry; differentiation of algebraic functions; rate, motion, maximum and minimum problems; deviations of higher order; curve sketching; basics in functions, limits, and continuity. *Prereq. 10.408 or 10.608.*

10.621 Calculus—A (4 cl., 4 q.h.)
Applications of derivatives to curvesketching; antidifferentiation; the definite integral, with applications; calculus of nonalgebraic functions—logarithmic, exponential, and trigonometric; calculus of inverse trigonometric functions; techniques of integration; indeterminate forms; L'Hospital's rule. *Prereq. 10.420 or 10.620.*

10.622 Calculus—B (3 cl., 4 q.h.)
Calculus of functions of several variables; partial differentiation; multiple integrals; infinite series; vector analysis; ordinary differential equations—standard types of the first order; some applications; special differential equations of the second order. *Prereq. 10.421 or 10.621.*

10.623 Calculus—C (4 cl., 4 q.h.)
Linear differential equations with constant coefficients, homogeneous and nonhomogeneous; variation of parameters, simultaneous differential equations; Laplace transform;

series and solution of differential equations by series; Fourier series; orthogonal functions. *Prereq. 10.422 or 10.622.*

10.627 Mathematics I (3 q.h.)
Sets, number systems, fundamental operations of algebra, exponents, radicals, linear equations. *Prereq. Math Placement Test, or 10.302, or 10.331.*

10.628 Mathematics II (3 q.h.)
Fractional equations; inequalities; functions, relations, graphs; quadratic equations; systems of equations; ratio, proportion, variation; logarithms. *Prereq. 10.627.*

10.629 Mathematics III (3 q.h.)
Progressions; introduction to calculus; rates of change, slopes, area under a curve, maximum and minimum problems; elementary matrix algebra. *Prereq. 10.628.*

10.632 Mathematics for Business Management I (3 q.h.)
Topics in mathematics applicable to management. Logic, set theory, probability with applications. Survey of mathematical models, linear models. *Prereq. 10.629 and 39.313, or equiv.*

10.633 Mathematics for Business Management II (3 q.h.)
Linear programming problems, solution by graphing. Matrix algebra, markov chains, directed graph models, mathematics of finance. *Prereq. 10.632.*

10.634 Mathematics for Business Management III (3 q.h.)
Statistical decision theory, utility theory, theory of games, regression-based models. *Prereq. 10.633.*

10.671 Basic Mathematics I (2 cl., 2 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.
A review of elementary algebra; algebraic expressions and operations, equations, word problems.

10.672 Basic Mathematics II (2 cl., 2 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.
Further review; operations with polynomials, factoring, fractional expressions, word problems. *Prereq. 10.671.*

10.681 Introduction to Mathematics I (4 cl., 4 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.
A comprehensive review of high school algebra, including first-degree equations, factoring, fractions, fractional equations, ratio and proportion, word problems, and concepts of plane geometry.

10.682 Introduction to Mathematics II (4 cl., 4 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.

Algebraic operations with complex fractions, mixed expressions, square roots, radicals, quadratic equations; simultaneous equations, graphs and fractional zero and negative exponents; the geometry of the right triangle, areas of polygons, circles, and loci problems. *Prereq. 10.681.*

10.683 Applied Mathematics & Statistics (3 q.h.)
The use of mathematics as a guide to concise thinking; the application of mathematical methods to highlight significant data. The use of elementary analytical models to test and evaluate hypotheses. An examination of the role of chance in physical phenomena. The importance of the use of a relevant statistical model. Methods for the selection of a data base. *Prereq. 10.682 or equiv.*

PHYSICS

Courses marked not available in every curriculum. See curricula in Academic Programs of Instruction section for applicable sequence, pp. 65–94.*

11.417 Physics I (Mechanics) (4 cl., 4 q.h.) (Day Curriculum)
Kinematics and dynamics of particle motion; Newton's laws; projectile and circular motion; conservation laws for momentum and energy; rational motion; simple harmonic motion. *Prereq. 10.407 or concurrently.*

11.418 Physics II (Properties of Matter, Heat, Wave Motion, Sound, Light) (4 cl., 4 q.h.) (Day Curriculum)
Elasticity; density and pressure; temperature; expansion; heat; change of state; heat transfer; vibrating systems; wave motion; properties of sound; properties of light. *Prereq. 11.417.*

11.419 Physics III (Electricity, Magnetism) (4 cl., 4 q.h.) (Day Curriculum)
Electrostatics; circuit elements; direct current circuits; magnetism; electromechanical devices; alternating current circuits; electronics; electromagnetic waves. *Prereq. 11.418.*

11.473 Physics Laboratory I (2½ lab., 2 q.h.) (Day Curriculum)
Same laboratory as 11.373 not listed. It is scheduled during the day program. *Prereq. 11.418.*

11.474 Physics Laboratory II (2½ lab., 2 q.h.) (Day Curriculum)
Same laboratory as 11.374 not listed. It is scheduled during the day program. *Prereq. 11.473.*

***11.604 General Physics I** (2 cl., 2 q.h.)
Survey of Newtonian mechanics; kinematics, and dynamics of particle motion; projectile and circular motion; conservation laws of energy and momentum. *Prereq. 10.627 or concurrently.*

***11.605 General Physics II** (2 cl., 2 q.h.)
Temperature; heat energy; mechanical equivalent of heat; wave motion; sound; Doppler's effect; elasticity and simple harmonic motion; rotational motion; fluids at rest in motion. *Prereq. 11.604.*

***11.606 General Physics III** (2 cl., 2 q.h.)
Fundamentals of electricity and magnetism; fields; potential; electric current; inductance; capacitance; electromagnetism; a-c and d-c series curcuits; properties of light; simple optical systems. *Prereq. 11.605.*

11.617 Physics I (Mechanics) (4 cl., 4 q.h.)
Vectors and balanced forces; accelerated motion; Newton's laws; projectile motion; work and energy; momentum; angular motion; centripetal force; rotation of rigid bodies; moment of inertia. *Prereq. 10.407, 10.607, or concurrently.*

11.618 Physics II (Properties of Matter, Heat, Wave Motion, Sound, Light) (4 cl., 4 q.h.)
Elasticity; density and pressure; temperature; the gas laws; heat transfer; thermodynamics; vibratory motion; wave motion; properties of sound; properties of light. *Prereq. 11.417 or 11.617.*

11.619 Physics III (Electricity, Magnetism (4 cl., 4 q.h.)
Electrostatics; circuit elements; direct current circuits; magnetism; electromechanical devices; alternating current circuits; electronics; electromagnetic waves. *Prereq. 11.418 or 11.618.*

11.624 Introductory Survey of Lasers (2 cl., 2 q.h.)
Physical principles and technology will be emphasized. Includes a review of the fundamental concepts of light and spectroscopy, the basic theory of lasers, studies of solid state; atomic, ionic, and molecular gas; organic dye; and semiconductor lasers. Related optics and detection will be discussed. *Prereq. 11.619.*

11.673 Physics Laboratory I (2½ cl., 2 q.h.)
First quarter of a two-quarter physics laboratory. Experiments in mechanics, fluid dynamics, and gas laws. *Prereq. 11.605, or 11.618, or concurrently.*

11.674 Physics Laboratory II (2½ cl., 2 q.h.)
A continuation of 11.673. Experiments in wave motion, optics, and electrical circuits.

11.681 Introductory Physics I (4 cl., 4 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.
An introduction to mechanics: units of measurement, vectors, accelerated motion, and Newton's laws of motion. *Prereq. none.*

11.682 Introductory Physics II (4 cl., 4 q.h.)
This credit cannot be used in the Associate in Engineering, Associate in Science, or the Bachelor of Engineering Technology degree programs.
Continuation of mechanics: conservation of energy and momentum. Introduction to elements of heat, thermodynamics, light, and electromagnetism. *Prereq. 11.681.*

SUPPLEMENTAL COURSES

93.305 Survival Training (2 cl., 2 q.h.)
Training in and demonstration of modern techniques of human survival; methods in the wilderness environment.

93.306 Flight Safety Seminar (2 cl., 2 q.h.)
The case-study method will be used to increase the pilot's awareness of some of the most important factors affecting aviation safety. Official aircraft accident reports released by the National Transportation Board of significant aviation accidents will be used at the beginning of each case study. Elements to be included: aircraft reliability, air traffic control system, weather, regulations, and pilot skills.

93.401 Technical Communications (4 cl., 4 q.h.) (Aeronautical Program)
Thought organization and effective sentences; written reports and instruction manuals; specifications and proposals; graphic aids and reproduction processes. *Prereq. 30.602.*

93.402 Technical Communications I (2 cl., 2 q.h.)
Thought organization and effective sentences; written reports and instruction manuals. *Prereq. 30.602.*

93.403 Technical Communications II (2 cl., 2 q.h.)
Specifications and proposals; graphic aids and reproduction processes. *Prereq. 93.402.*

93.404 Technical Communications (3 q.h.)
Thought organization and effective sentences; written reports and instruction manuals; specifications and proposals; graphic aids, and reproduction processes. *Prereq. 30.306, or 30.304 and 30.305.*

93.502 Technical Mathematics (4 cl., 4 q.h.)
Fundamental algebraic operations; complex numbers; radicals and exponentials; logarithms; linear and quadratic equations; trigonometric functions of angles; identities; triangles and complex numbers in trigonometric form. Coverage adapted to the requirements of the program.

93.504 Electrical Circuits and Electronics I (4 cl., 4 q.h.)
Basic definitions; current, voltage, resistance, capacitance, inductance, power and energy sources; circuits, circuit laws and theorems. Diodes, bipolar and field-effect devices, biasing techniques. Introduction to a basic amplifier.

93.506 Electrical Instruments and Measurements (4 cl., 4 q.h.)
Combination of lectures, demonstrations, and experiments conducted in the laboratory. Introduction to the basic electronic instruments and electrical measurements. Demonstrations and experiments, based on and in parallel with the material presented in the lectures.

93.508 Electrical Circuits and Circuits Laboratory II (4 cl., 4 q.h.)
AC theory; impedance; introduction to frequency domain; spectrum and filters; Bode plots. *Prereq. 93.502, 93.504, 93.506.*

93.510 Electronics and Electronics Laboratory II (4 cl., 4 q.h.)
Small signal semiconductor device models and amplifier circuits. Cascading of stages. *Prereq. 93.502, 93.504, 93.506.*

Note: Laboratory work is based on the material covered in the lectures. Included are demonstrations by the instructor, as well as experiments performed by the student to reinforce the material presented in respective lectures. The laboratory work will follow the lecture on the same night.

93.512 Cable Communications and Cable Laboratory I (4 cl., 4 q.h.)
Lectures, demonstrations, and experiments to introduce the student to the principles of cable communication system: introduction to modulated signal-transmission systems, transmission line characteristics, cascaded amplifiers and repeaters. *Prereq. 93.502, 93.504, 93.506.*

93.514 Electronics II and Electronics Laboratory (4 cl., 4 q.h.)
Introduction to digital electronics and logic circuits; fundamentals of Boolean Algebra; gates, flip-flops, registers and counters, logic families. *Prereq. 93.508, 93.510, 93.512.*

93.516 Cable Communication II and Cable Laboratory II (4 cl., 4 q.h.)
Video and cable-system performance tests, and tests and measurements; modulation-demodulation tests; transmission line and repeater-amplifier tests, and distortion measurements; FCC proof of compliance/performance measurements. *Prereq. 93.508, 93.510, 93.512.*

93.518 Special Topics and Special Topics Laboratory (4 cl., 4 q.h.)
Satellite receiving and the head-end systems; cable-system design; and other related topics. *Prereq. 93.508, 93.510, 93.512.*

93.550 Concepts of Modern Technology I (3 q.h.)
A survey of the applications of physical science to mechanical devices. An introduction to the laws of thermodynamics. The influence of material properties on design and manufacturing techniques. *Prereq. 10.382 or equiv.*

93.551 Concepts of Modern Technology II (3 q.h.)
A survey of the applications of physical science to electrical and electronic devices. An introduction to electronic circuit design. A comparison of various devices used for amplification and control. A study of the development of the electronic digital computer and the components involved in the manufacture of computers. *Prereq. 93.550.*

93.552 Measurement and Analysis (3 q.h.)
A survey of instruments and techniques used to assure performance of electrical and mechanical components. An introduction to trouble-shooting and automated testing. A study of destructive and nondestructive tests and their relationship to each other. *Prereq. 93.550 and 93.551.*

93.553 Modern Electronics (3 q.h.)
A survey of components available to the designer of electronic devices, including linear integrated circuits and digital building blocks. Topics discussed will include: operational amplifier characteristics; truth tables and the synthesis of digital logic; logic families and specifications; counters, registers and decoding; digital instruments, digital to analog conversion. *Prereq. 93.551.*

93.554 Theory and Operation of Computers (3 q.h.)
An introduction to digital computer design and operation. Design topics include Boolean Algebra, synthesis of switching networks, and an introduction to general computer ar-

chitecture and organization. Operational topics include input and output devices, systems development, programming tools, data communication, time sharing, data-base principle. *Prereq. 10.382 or equiv.*

93.604 Technical Communications (3 q.h.)
Thought organization and effective sentences; written reports and instruction manuals; specifications and proposals; graphic aids and reproduction processes. *Prereq. 30.306, or 30.304 and 30.305.*

93.606 Technical Communications I (3 q.h.)
Experiments with inexpensive and practical techniques to create competitive written and spoken presentations of a professional calibre. Topics include written and spoken presentations and audio-visual aids and presentations. *Prereq. 30.306 and 09.670.*

93.607 Technical Communications II (3 q.h.)
Experiments in the organizing, researching, and writing techniques essential to engineering management. The course leads students through an intensive examination and utilization of professional technical writing techniques. *Prereq. 93.606.*

93.610 Solar Water Heating (2 cl., 2 q.h.)
General types of solar water heaters; basic science and historical development of solar water-heating systems; design and installation of a typical system; cost benefits and savings; maintenance and payback.

93.611 Solar-Heating Design (2 cl., 2 q.h.)
Fundamentals of heat, heat transfer, insulation; sun angles, intensity and siting problems; system layouts; heat storage and heat exchangers; controls and sensing devices; design calculations and design practice. *Prereq. 93.610.*

93.650 The Technical Presentation (3 q.h.)
The application of technical communication to audiovisual presentations. Includes audience analysis, techniques of organization, script preparation, media selection, the design and production of visuals, the influence of physical factors on communication, and the elements of effective delivery. Participants will prepare and deliver technical presentations with video playback and peer critiques.

AERONAUTICAL TECHNOLOGY

Descriptions of flight training courses are included solely to provide guidelines for students in the flight portion of the Aeronautical Technology program.

96.308 Aircraft Power and Systems (4 cl., 4 q.h.)
Engine types, nomenclature, and engine development; engine cycles and principles, performance, power and its measurement, ratings; engine parts and their functions; valve mechanisms and timing; cooling system, carburation, fuel system, ignition system, lubrication, and oil system; batteries, propeller and engine breathing system.

96.324 Introductory Avionics (4 cl., 4 q.h.)
Basic coverage of electronics, including: vacuum tube principles, semiconductor physics principles, power supplies, amplifiers, oscillators, and pulse circuits; generator and motor

principles and applications; basic concepts of avionics, electrical hazards, aircraft electrical systems, electrical instruments, strobe lights, FCC regulations, radio communications, and antennas. *Prereq. 11.619, 10.608.*

96.325 Avionics (4 cl., 4 q.h.)
Reliability and maintainability of avionics, automatic direction finders, marker beacons, omnirange and localizers, audio switching systems. ATC transponders, glide slope systems, distance measuring equipment, autopilots, missile guidance, and new state-of-the-art avionics. *Prereq. 96.324.*

96.334 Private Flight Laboratory (8 lab., 4 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the private pilot certificate, airplane rating, single engine. *Prereq. Class I or II medical certificate.*

96.335 Instructional Flight Laboratory (6 lab., 3 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the instructor certificate, airplane rating, single engine. *Prereq. 96.339.*

96.336 Instrument Instructor Laboratory (4 lab., 2 q.h.)
Consists of necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the instrument flight instructor rating, airplane, single engine. *Prereq. 96.335.*

96.338 Commercial Flight Laboratory (16 lab., 8 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the commercial pilot certificate, airplane rating, single engine. *Prereq. 96.334.*

96.339 Instrument Flight Laboratory (8 lab., 4 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the instrument rating, airplane. *Prereq. 96.334 or 96.439.*

96.340 Multi-Engine Flight Laboratory (2 lab., 1 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the multi-engine rating, airplane. *Prereq. 96.334.*

96.358 Helicopter A (2 lab., 2 q.h.)
This course, in conjunction with part B, consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the helicopter rating. *Prereq. Commercial Fixed Wing License; Class I or II medical certificate.*

96.359 Helicopter B (2 lab., 2 q.h.)
This course, in conjunction with part A, consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the helicopter rating. *Prereq. 96.358.*

96.404 Fundamentals of Aeronautics (4 cl., 4 q.h.)
Aircraft structures and components; aerodynamic forces; airfoil terminology—lift and drag coefficient; boundary layer problems and control; earth in space latitude; longitude; properties and components of the atmosphere; map projections, dead reckoning; reciprocating engine theory; planform effects; aircraft weight and balance. Radio navigation; VOR, ADF, DME, and TACAN; airplane performance (climb, range, altitude, takeoff, and landing); aircraft propeller theory and operation; specific aircraft substructures (landing gear, etc.); advanced DR navigation problems (radius of action, unknown wind); physiology factors of flight; general review. Federal Aviation Regulations for Private Pilot.

96.405 Weather Station Operation and Observations I (4 cl., 4 q.h.)
Design, care, and operation of meteorological instruments, observing, coding, and recording data for aviation and synoptic reports. Map plotting, analysis, and use. Pseudoadiabatic diagram plotting and use. Routine duties of weather observer. Elementary forecasting theory. Trips to local weather stations, flight service stations, and weather radar installations. *Prereq. 96.396.*

96.406 Weather Station Operation and Observations II (4 cl., 4 q.h.)
A continuation of Weather Station Operation and Observations I. *Prereq. 96.405.*

96.407 Flight Engineering I (4 cl., 4 q.h.)
This is a preliminary course giving students the basic knowledge and exposure of the operating systems of large transport type aircraft. They will receive the basic systems knowledge of the Boeing 727. The major area of concentration will be aircraft general, pneumatic systems, hydraulic systems, fuel systems, electrical systems, pressurization systems, and engine operations. Upon successful completion of this course and recommendation from the instructor, students will be permitted to proceed with Flight Engineering II. *Prereq. Commercial License, Instrument Rating.*

96.408 Advanced Flight Mechanics (4 cl., 4 q.h.)
Aerodynamics, performance, stability and control, flight efficiency. *Prereq. 96.437.*

96.409 Practice of Flight Instruction (4 cl., 4 q.h.)
Fundamentals and principles of instructing; learning concepts of teacher procedures. Preparation for Federal Aviation Administration fundamentals of instruction written exam. Practice for basic, advanced, and instrument Federal Aviation Administration ground instructor exam. *Prereq. Permission of staff.*

96.410 Aviation History I (4 cl., 4 q.h.)
Detailed historical analysis from the dawn of aviation to World War II of efforts in manned flight, aircraft development, pioneers in flight, general aviation, military and commercial aspects of flight, and effects on modern civilization.

96.411 Aviation History II (4 cl., 4 q.h.)
A continuation of detailed historical analysis from the beginning of World War II through the space age. *Prereq. 96.410.*

96.412 Aviation Safety I (4 cl., 4 q.h.)
Commuter and multi-engine aircraft accidents. The course is divided into two sections. The first section deals with commuter airlines safety problems. A general view of com-

muter airline problems will be given. This will be followed by two case studies. The second section deals with the differences in two-engine operating requirements, according to the section of the Federal Aviation Regulations under which the aircraft is certified. Differences in safe operating procedures will be examined in detail. Commonly misunderstood terms of vital importance to safe multi-engine aircraft operation will be explained and illustrated.

96.413 Aviation Safety II (4 cl., 4 q.h.)
San Diego: A case study. A thorough examination of the various factors involved in the worst mid-air collision in American civil aviation history and its aftermath. Elements analyzed in detail include: FAA regulations and policies; air traffic control procedures; the actual tapes between air traffic controllers and pilots; pilot's cockpit conversations; eyewitness reports; National Transportation Safety Board's public hearing and subsequent report; Congressional hearings; news media coverage and resulting legal ramifications. An extensive multi-image slide presentation is used to aid the student's comprehension of time, critical events, and ultimate consequences. *Prereq. 96.412.*

96.414 Aviation Safety III (4 cl., 4 q.h.)
Significant aviation accidents/incidents: Case studies of aircraft accidents/incidents selected because of the vital issues of aviation safety involved. Drawing upon the student's knowledge acquired from the San Diego case study, the vital issues of a number of important aviation accidents will be studied. Each case study will focus only upon the most important elements, so that the study may gather a broad perspective of the safety issues involved. Case studies to be presented, among many, include the worst crash in American civil aviation and the collision at Tenerife—the worst disaster in aviation history. *Prereq. 96.413.*

96.415 Advanced Meteorology and Climatology (4 cl., 4 q.h.)
Physical approach to pressure, temperature, basic thermodynamics, stability, and cloud formations; elementary polar front theory; the general circulation of the atmosphere; climate causes and effects; climatology of several regions of the world; application of climatology to problems of airport location and construction, airline operation, and general aviation. *Prereq. 96.444.*

94.416 Flight Operations and Traffic System Seminars (4 cl., 4 q.h.)
Discusses complex topics pertaining to such areas as the air traffic system, aircraft operation, and weather. Content will generally be flexible to satisfy the participant's demand for solutions to problem areas. Experts in various fields will generally be employed as guest lecturers to enhance the course. *Prereq. Permission of staff.*

96.417 General Aviation Operations (4 cl., 4 q.h.)
A presentation of the major functions and problems of current airport management; organization, zoning, adequacy, financing, revenues and expenses, evaluation, and safety; the airport and its socioeconomic effect on the community. Study and analysis of airport functions, such as fixed-base operators, pilot training schools; airtaxi operations in both charter and schedule activities, corporate aviation. Master planning of airports is introduced in a general manner.

96.418 Intermodal Transportation (4 cl., 4 q.h.)
An overview of the major characteristics and current problems of each mode of transportation—air, rail, maritime, intercity, bus, motor carrier, and transit. Probes the interrelationships among the major modes of transportation. *Prereq. none.*

96.419 Air Cargo (4 cl., 4 q.h.)
Study of commercial airline and air freight forward cargo practices, with emphasis on regulation, economics, marketing, handling, and organizational aspects.

96.420 Airline Traffic and Sales (4 cl., 4 q.h.)
Functions of the commercial airline traffic and sales department, relationship between the travel agencies and the airlines, relationships with other carriers, reservations and the procedures involved in the interline of the passenger to another carrier; airlines promotion. Tariffs and schedules, with an explanation of how flight times are established; flight summary frequencies; new routes; establishment of ticket fares, aspects of cargo and charters. *Prereq. none.*

96.421 Air Traffic Control System (4 cl., 4 q.h.)
Survey of the total aerospace system and management; air traffic administrative coordination; regional responsibilities; NAFEC organization of center, tower, and station. *Prereq. 96.437 or 96.438.*

96.422 Flight Physiology and Survival Techniques (4 cl., 4 q.h.)
The study of the physical and chemical processes of the body; functions of the living body and its environment; adaptive changes of function of the body resulting from a change in environment, with emphasis on flight; the effects of medication on the function and reactions of the body, with emphasis on flight; the effects of the state of the mind on the function and reactions of the body, with emphasis on flight. Training in and demonstration of modern techniques of human survival methods in the wilderness environment. *Prereq. none.*

96.423 Turbine Engines (4 cl., 4 q.h.)
A presentation of turbine engine types and their development; centrifugal flow and axial flow types, turbo-prop, turbo-shaft, turbo-jet, turbo-fan, ram jets, pulse jets, and rockets; principles of combustion and propulsion, performance, power, thrust, and their measurement; fuel, lubrication, and ignition systems. *Prereq. 96.308.*

96.430 Aviation Preventive Maintenance (2 cl., 2 q.h.)
For pilots and aircraft owners. Airframe and powerplant nomenclature, structures, and systems; maintenance that a pilot can and is allowed to do to the airframe and engine of his aircraft; proper techniques.

96.434 Aircraft Accident Investigation and the Aviation Professional—A
(4 cl., 4 q.h.)
Purpose and legal source of aircraft accident investigation; the rights, obligations, and limitations of the National Transportation Safety Board (NTSB), Federal Aviation Administration (FAA), parties-to-the-investigation. *Prereq. Permission of staff.*

96.435 Aircraft Accident Investigation and the Aviation Professional—B
(2 cl., 2 q.h.)
A condensed version of 96.434. *Prereq. Permission of staff.*

96.437 Advanced Aeronautics (4 cl., 4 q.h.)
Aircraft structural limitations, aerodynamics and forces, aircraft weight and balance, advanced airplane performance, stability and control, spins and commercial flight maneu-

vers, high performance aircraft, commercial pilot Federal Air Regulations, introduction to part 135 FAR's and introduction to flight engineering; preparation for airplane commercial written test. *Prereq. 96.404.*

96.438 Instrument Procedures (4 cl., 4 q.h.)
Aerodynamics, instrument flight charts; IFR planning; aviation weather; instrument flight rules; static and dynamic stability of aircraft; control movements and forces. Spins and spin recoveries; clearance notation; aircraft performance; instruments and scanning procedures; structural strength limitations; precision approach radar and airport surveillance radar; pressure pattern flight. Preparation for Federal Aviation Administration instrument written exam. *Prereq. 96.404.*

96.439 Advanced Flight Laboratory (4 q.h.)
Consists of the necessary flight training and instruction to satisfy the minimum Federal Aviation Administration requirements to apply for the flight test for the commercial pilot certificate, airplane rating, single engine. *Prereq. 96.334.*

96.440 Introduction to Aircraft Design (4 cl., 4 q.h.)
Basic orthographic principles and interpretations of aircraft design; a presentation of basic aerodynamics, structural characteristics of aircraft, materials, and manufacturing processes. *Prereq. 10.307.*

96.441 Introduction to Aerodynamics (4 cl., 4 q.h.)
A noncalculus presentation of basic fluid dynamics and principles of fluid flow includes continuity, Bernoulli, and momentum equations; streamlines, stream tubes, drag, theory of lift, wing theory, vortex flow, ground effect, stalls, boundary layer, flow separation, control surfaces, stability, and balance. *Prereq. 10.608 and 11.618 or 10.408 and 11.418.*

96.442 Basic Helicopter Aerodynamics (4 cl., 4 q.h.)
General aerodynamics; helicopter components and their functions; loads and load factors; gyroscope precession principle; performance; introduction to flight manual, helicopter operations in confined areas, precautionary measures and critical conditions. *Prereq. 96.404.*

96.443 Aircraft Systems (4 cl., 4 q.h.)
Hydraulic, pneumatic, electrical, and mechanical systems; landing gear types, design loads and limitations; landing gear retraction systems; general flight control systems, including rudder, elevator, aileron, and flaps; loads and limitations, deicer systems for flight surfaces, cabin pressurization and oxygen systems; electrical and air-driven instrument systems. Analysis of high performance business aircraft systems. *Prereq. 96.437.*

96.444 Meteorology and Climatology (4 cl., 4 q.h.)
A survey of the principles and structure of the atmosphere; pressure systems and fronts; tropical meteorology; meteorological instruments and observations; weather map interpretation and common aviation weather teletype codes. *Prereq. 11.418.*

96.445 Advanced Flight Mechanics (4 cl., 4 q.h.)
Aerodynamics, performance, stability and control, flight efficiency. *Prereq. 96.437.*

96.500 Tactical Air Field Refueling System (cl. special, 4 q.h.)
Classroom and practical training will be utilized to ensure student capability to both operate and maintain the tactical air field refueling system. Practical applications to make the student aware of 1) set-up; 2) terrain features; 3) operation of pumps and bladders for possible problems and actions to be taken; 4) fuel testing for contamination. Will be conducted utilizing the actual physical equipment.

the lincoln college faculty

The strength of an educational institution lies in the quality of its faculty. This is especially true in a college devoted to the training of mature men and women, many of whom are already employed in their chosen professions.

The instructional staff of Lincoln College is composed of professional academicians from Northeastern University and neighboring educational institutions, and practicing professionals from the scientific and industrial community of Greater Boston. The theoretical training and practical experience represented by this combination of specialists are ideally suited to the technology programs they teach and the adult students they serve.

The faculty are selected for their ability and active interest in the welfare of ambitious part-time students. They are men and women of culture and high ideals, and are qualified by educational training and professional experience to teach effectively in their respective fields.

A staff of experienced professional educators who serve as program and course consultants constitutes the Academic Advisory Council and Curriculum Advisory Committee of the College. They guide, supervise, and assist with the administration of courses and programs.

THE FACULTY

The following is an alphabetical list of the faculty of Lincoln College; degrees earned; professional affiliation; and Lincoln College department (year of appointment).

Arnold M. Aaron, B.S., M.S., Ph.D.
Engineer, Naval Underwater Systems Center
Electrical Engineering Technology (1974)

Velda Adams, M.S.
Member, Technical Staff, GTE Labs.
Computer Technology (1980)

*Arnold W. Almquist, Jr., B.S., M.Ed.
Mathematics Instructor, Needham High School
Mathematics (1967)

Peter Anderson, B.S., M.S.
Electrical Engineer, Stein Associates, Inc.
Electrical Engineering (1976)

*Robert B. Angus, Jr., B.S., M.S., P.E. (Mass.)
Principal and Consultant, Angus Associates
Electrical Engineering Technology (1947)

**Appointed to the rank of Senior Lecturer*

Russell S. Arena, A.S., B.S.
ASSWT-Chief Pilot, E.W. Wiggins Airways, Digital Equipment Corp.
Aeronautical Technology (1980)

*Robert J. Averill, B.S., M.S.
Executive Vice President, Sala Magnetics, Inc.
Course Consultant, Electrical Engineering Technology (1957)

John S. Ballas, B.S., M.S., M.B.A.
Dir. of Eng., Brattle Instruments Corp.
Electrical Engineering Technology (1981)

John C. Balsavich
Laboratory Supervisor, Electrical Engineering, Northeastern University
Electrical Engineering Technology (1957)

Henry G. Barry, M.Ed.
Newton School System
Mathematics (1979)

Adolph Baumann, B.S., P.E. (Mass.)
Telecommunications Eng., GTE Sylvania
Electrical Engineering Technology (1955)

*Matteo P. Berardi, B.S., M.S.E.I.T. (Mass.)
Supervisor, Stone & Webster Eng. Corp.
Mechanical Engineering Technology (1960)

Maureen P. Berggren, B.S.
Mathematics (1965)

Ralph S. Blanchard, B.S.M.E., M.S.M.E., P.E. (Mass.)
Assistant Dean, College of Engineering, Northeastern University
Assoc. Program Consultant, Mechanical Engineering Technology (1950)

Robert E. Bobeck
Professor, Bristol Community College
Engineering Graphics (1976)

*Edward Bobroff, B.M.E.
Engineering Consultant, Medical Area Total Energy Plant
Program Consultant, Mathematics (1946)

Alan Bradshaw, B.S., M.S., C.A.G.S. (Mass.)
Superintendent, Chelmsford School System
Mathematics (1966)

*Eugene G. Branca, S.B., S.M.
Assistant Headmaster (Retired), Hyde Park High School
Course Consultant, Mathematics (1946)

*Donald H. Breslow, S.B., M.S.
Director of Engineering, Measurement Systems Division, Itek Corp.
Electrical Engineering Technology (1959)

*Donald C. Brock, B.S., M.S.
Mathematics Instructor, Needham High School
Mathematics (1965)

*Franklyn K. Brown, B.S.Ed., M.Ed.
Associate Professor, Design Graphics, Northeastern University
Course Consultant, Engineering Graphics and Computation (1955)

Jeffrey L. Bruce, B.S., M.A.
Software Engineer, Raytheon Missiles Division
Mathematics (1969)

*Morris H. Burakoff, B.S., P.E. (Mass.)
Department Chief, Western Electric Company
Electrical Engineering Technology (1957)

**Appointed to the rank of Senior Lecturer*

*Leroy M. Cahoon, B.S.C.E., M.S., P.E. (Mass., Conn.)
Associate Professor of Civil Engineering, Northeastern University
Program Consultant, Civil Engineering Technology (1962)

*Frank R. Cangiano, B.S., Ed.M.
Instructor in Science and Mathematics, Medford High School
Mathematics (1957)

Edgar T. Canty, B.S., M.S.
Director, Academic Computing Services, Babson College
Mathematics (1966)

Joseph M. Cardito, B.S., M.S., Ph.D., P.E. (Mass.), C.H.P. (Amer. Brd. Health Physics)
Supervisor, Nuclear Fuels and Data Systems, Stone & Webster Eng. Corp.
Mechanical Engineering Technology (1978)

Alfred F. Carpenito, B.S., M.Ed., M.A.Ed.
Retired Assistant Headmaster, Boston Technical H.S.
Engineering Graphics (1965)

Robert W. Case, Ph.D.
Coordinator for Day Program, Lincoln College
Mathematics (1976)

*Walter J. Casey, A.B., M.Ed., M.A.T.
Dept. Chairman, Brighton High School
Mathematics (1955)

Margret P. Casper, A.B., M.Ed.
King Philip Regional School District
Mathematics (1977)

Joan M. Chrusciel, B.S., M.Ed., M.A.
Mathematics Teacher, Quincy High School
Mathematics (1980)

Vincent L. Cocco, B.S.
Senior Engineer, Polaroid Corporation
Mechanical Engineering Technology (1978)

Thomas C. Coleman, B.S.M.E., M.S.M.E., Ph.D., P.E. (Mass.)
Supervising Mech. Engineer, United Engineering and Construction
Course Consultant, Mechanical Engineering Technology (1960)

Wendell R. Collymore
Drafting Supervisor, Polaroid Corporation
Engineering Graphics (1976)

Leonard M. Conlin, A.B., Ed.M.
Mathematics Teacher, Framingham North High School
Mathematics (1967)

*Roger T. Connor, A.B., M.Ed.
Teacher, Milton Academy
Course Consultant, Calculus (1953)

*Robert J. Connors, B.S.
Manager of Technology, Electronic Systems, Sylvania Electric Products, Inc.
Electrical Engineering Technology (1948)

*Joseph Z. Cooper, B.S.E.E.
Principal Engineer, Raytheon Company
Computer Technology (1967)

*James B. Corscadden, B.S., M.Ed., A.M.T.
Assistant Headmaster, South Boston High School
Mathematics (1967)

Edward F. Crosby, B.S.E.E., M.B.S., P.E. (Mass.)
Training Manager, New England Telephone
Engineering Economy (1980)

**Appointed to the rank of Senior Lecturer*

David C. Crockett, B.S., M.S.
Senior Engineer, Raytheon Company
Mechanical Engineering Technology (1969)

Steven S. Cushman, B.S.
Software Consultant
Computer Technology (1977)

*Herbert R. Davenport, B.S.E.E.
Standards Engineer, GenRad Inc.
Electrical Engineering Technology (1948)

*Warren C. Dean, A.B., M.A.
Professor of Mathematics, Northeastern University
Mathematics (1941)

Charles A. DeAngelis, B.S., M.S., P.E. (Mass., Ind.)
Senior Structural Engineer, Stone & Webster Eng. Corp.
Civil Engineering Technology (1976)

*John L. Dearness, A.S.E.E., B.S.E.E. (Equiv.)
Branch Manager (Quality Assurance), Northrop Corporation
Aeronautical Technology (1972)

Peter DeCenzo, B.S.
Mathematics Teacher, Ashland High School
Mathematics (1979)

Richard Deveney, B.A., M.Ed.
Mathematics Instructor, Boston Public Schools
Mathematics (1978)

Thomas R. Deveney, B.S., M.A.
Basic Skills Coordinator K-12, Boston Public Schools
Mathematics (1965)

Jane E. DeVoe, B.S., M.A.
Director, Project SEED
Mathematics (1980)

Douglas H. Diamond, B.E.E.
Program Manager, Analytical Systems Eng. Corp.
Mathematics (1968)

*Giles C. Dilg, B.S.E.E., M.S.E.E., P.E. (Mass.)
Manager, Honeywell Info. Systems
Engineering Graphics (1966)

Marie Dolansky, B.S., M.Ed., Ed.D.
Instructor, Mathematics, Northeastern University
Mathematics (1964)

Mark Domaszewicz, B.E.E., M.S.E.E.
Senior Engineer, Raytheon Company
Electrical Engineering Technology (1970)

Leonard F. Dow, B.S.E.E., M.S., P.E. (Mass.)
Staff Engineer, Boston Edison Company
Electrical Engineering Technology (1970)

Philip W. Dunphy, B.Sc., M.Ed.
Associate Professor, Cooperative Education, Northeastern University
Academic Counselor (1967)

*William V. Durante, B.S., M.Ed., M.A.
Assistant Headmaster of Mathematics, Boston Latin School
Course Consultant, Mathematics (1964)

John A. Ebacher, B.S., M.S.
Mgr., Advanced Engine Systems Analysis, General Electric Co.
Mechanical Engineering Technology (1967)

**Appointed to the rank of Senior Lecturer*

Henry B. Eden, B.S.
President, Anco Boston, Inc.
Engineering Graphics (1957)

David T. Ellis, B.S., M.S.
Engineering Manager, Digital Equipment Corp.
Electrical Engineering Technology (1978)

Adolf J. Erikson, B.B.A., M.B.A., P.E. (Mass.)
President, A.E. Engineering Corporation
Engineering Graphics (1966)

Thomas C. Fantasia, M.S.E.E., B.S.E.E.
Electrical Engineering, Boston Edison Company
Electrical Engineering Technology (1981)

Edwin H. Farr, B.S., M.S., Ph.D.
U.S. Dept. of Transportation
Mathematics (1980)

Richard Fields, B.S., M.S.
Meteorologist, Minuteman Weather Service
Aeronautical Technology (1980)

*William D. Finan, A.B., M.A., D.Ed.
Reading Director, Needham Public Schools
Course Consultant, Mathematics (1946)

*Louis A. Fiore, A.E., B.B.A.
Chief Draftsman, American Science and Engineering, Inc.
Engineering Graphics (1956)

John M. Flaherty, B.S., M.S., Ph.D.
Advanced R&D Physicist, GTE Sylvania, Inc.
Electrical Engineering Technology (1976)

James J. Flannery, B.S.E.E., M.S.E.E., P.E. (Mass.)
Engineering Computer Applications, Division Head Boston Edison
Power Systems (1980)

Peter F. Gibbs, M.B.A.
Special Consultant
Aeronautical Technology

*Peter D. Gianino, B.S., M.S.
Research Physicist, R.A.D.C., Hanscom A. F. Base
Course Consultant, Differential Equations (1980)
Mathematics (1965)

Sheldon L. Glickler, B.S., M.S.
Program Manager, G.C.A. Corp.
Mechanical Engineering Technology (1969)

*William B. Goggins, Jr., B.S., M.S.E.E., Ph.D.
Staff Member, M.I.T. Lincoln Labs.
Electrical Engineering Technology (1964)

*David Goldberg, B.S., M.S.E.E., M.S.E.M.
Program Manager, GTE Sylvania
Course Consultant, Engineering Graphics (1969)

Bernard F. Goldstein, B.S., M.S., Ph.D.
Senior Analyst, Dynamics Research Corporation
Electrical Engineering Technology (1974)

Forest W. Grumney, B.A., M.B.A.
Corporate Vice President, Human Resources
Mathematics (1963)

Alan Hadad, B.A., M.A., M.S.
Associate Professor, Wentworth Institute
Mathematics (1979)

**Appointed to the rank of Senior Lecturer*

*Francis R. Hankard, S.B., M.A.
Assistant Chief of Lab., Mass. Dept. of Public Safety
Program Consultant, Physics (1946)

*Joseph J. Hansen, A.B., M.B.A.
Director, Planning Analysis, and Assistant Director, Strategic Planning, Raytheon Company
Assoc. Program Consultant, Mathematics (1959)

*George C. Harrison, B.S., M.S.
Senior Principal Electronic Engineer, Polaroid Corporation
Electrical Engineering Technology (1962)

*Harold Harutunian, A.B., M.A.T., Ed.D.
Prof., Salem State College
Mathematics (1965)

Lewis H. Holzman, B.S.C.E., S.M.C.E., P.E. (Mass.), R.L.S. (Mass.)
Consultant, Computer Department, Stone & Webster Eng. Corp.
Computer Technology (1966)

C. Gregory Hood, B.S., M.A., Ph.D.
Newton Public Schools
Physics (1975)

Udo Hoppenz, B.S., M.S.
Associate Professor of Physics, Wentworth Institute
Mathematics (1979)

Charles E. Jacob, B.S.E.E., M.S.Ed., M.L.S.
Master, Boston Latin School
Physics (1967)

*Arthur W. John, B.S.E.E., M.S., M.B.A.
Manager of Engineering Training and Administration, Data General Corp.
Physics (1968)

Eugene F. Joyce
Technician, Electrical Engineering Dept., Northeastern University
Electrical Engineering Technology (1963)

Rosaleen Johnson, B.S., M.A.
Victor Electronics
Mathematics (1981)

*John Kaczorowski, Jr., B.S.E.E., M.S.E.E.
Dean of External Programs, Wentworth Institute
Assoc. Program Consultant, Electrical Engineering Technology (1970)

*Leon Katler, Certificate P.E. (Mass., Me., N.Y., Pa., Va.)
Senior Structural Engineer, Stone & Webster Eng. Corp.
Civil Engineering Technology (1963)

Phillip T. Karatzas, B.S., M.S.
Nuclear Technology Engineer, Stone & Webster Eng. Corp.
Physics (1978)

*Louis Katona, B.C.E., M.C.E., P.E. (Mass., N.Y.)
Senior Hydraulic Engineer, Badger America, Inc.
Civil Engineering Technology (1959)

Sidney W. Kaye, B.Sc., M.Ed.
Senior Engineer, Raytheon Company
Mathematics (1967)

*George F. Kent, B.S., M.S., M.B.A., P.E. (Mass.)
Assistant Chief Engineer, Stone & Webster Eng. Corp.
Course Consultant, Materials (1962)

Bernard J. Kiley, B.E., M.E., P.E. (N.H., Mass., Conn.)
Senior Structural Engineer, Stone & Webster Eng. Corp.
Mechanical Engineering Technology (1958)

**Appointed to the rank of Senior Lecturer*

*John J. Klein, B.S., M.S.
Manager, Design Engineering, Radio Corporation of America
Electrical Engineering Technology (1950)

Joseph C. LaCroix, B.A., M.Ed., C.A.G.S.
Chairman of Math. Dept., Dorchester High School
Mathematics (1974)

*Robert S. Lang, B.S., Ed.M.
Associate Professor, Industrial Engineering and Information Systems, Northeastern University.
Program Consultant, Engineering Graphics (1955)

Carl Leone, Jr., A.B., M.S.
Coord. of Athletics and Transportation, Quincy Public Schools
Mathematics (1965)

A. Richard LeSchack, A.B., A.M.
Applied Mathematician, The Analytical Sciences Corp.
Mathematics (1968)

Alvin J. Lesieur, B.S., M.Ed.
Instructor, Braintree High School
Engineering Graphics (1965)

Sandra M. Licter, B.S.Ed., M.Ed.
Assoc. Software Engineer, Raytheon Company
Mathematics (1967)

*Demetre P. Ligor, B.S.E.E., P.E. (Mass.)
President, Applied Measurements, Inc.
Course Consultant, Physics (1959)

Warren J. Little, B.S., M.S.
Technical Staff, Charles Stark Draper Labs., Inc.
Physics (1966)

George M. Livingstone, Jr., B.S.
Private Practice
Civil Engineering Technology (1975)

*Andrew G. Lofgren, A.A., Ed.M., P.E. (Mass.)
Self-Employed; Consultant and Lecturer on ANSI-Y14.5
Mechanical Engineering Technology (1946)

Bertram S. Long
Associate Prof. Mechanical Eng., Northeastern University
Assoc. Program Consultant, Mechanical Engineering Technology (1975)

*Roger G. Long, A.E., B.B.A., P.E. (Mass.)
Senior Staff, Arthur D. Little
Electrical Engineering Technology (1952)

*Kenneth A. Lucas, B.S., M.Ed., P.E. (Mass.), R.L.S. (Mass., Me., N.H.)
President, Mass. School of Survey, Inc.
Civil Engineering Technology (1950)

John F. Lutkevich, A.E., B.B.A.
Engineer-in-Charge, GTE Sylvania
Engineering Graphics (1956)

*Alan A. Mackey, B.S., M.A.
Associate Dean, University College, Northeastern University
Mathematics (1952)

Anton Mavretic, B.S., M.S., Ph.D.
Associate Professor, Boston University
Assoc. Program Consultant, Electrical Engineering Technology (1969)

*Edward McCarren, Jr., A.E.
Product Engineer, Analog Devices, Inc.
Electrical Engineering Technology (1951)

**Appointed to the rank of Senior Lecturer*

*Carl J. Mellea, S.B., M.S., P.E. (Mass., R.I., Maine, Vt., N.H.)
Project Engineer, Howard, Needles, Tammen & Bergendorff
Civil Engineering Technology (1960)

Robert L. Meserve, B.S., M.S.
Assoc. Professor, Civil Engineering, Northeastern University
Civil Engineering Technology (1978)

*Walter Messcher, B.M.E., M.S.
Project Manager, U.S. Department of Transportation
Program Consultant, Computer Technology (1966)

Richard W. Miller, B.S., M.S., P.E. (Mass.)
Principal Research Engineer, The Foxboro Company
Mechanical Engineering Technology (1959)

*Ernest E. Mills, B.S., M.S., P.E. (Mass.)
Program Coordinator of Mechanical Engineering Technology and
Associate Professor of Mechanical Engineering Technology
Lincoln College, Day and Evening Programs (1946)

Louis A. Moore, A.E., B.E.T., B.S.C.E., R.L.S. (Mass.)
Deputy Engineer, Commonwealth of Mass., Land Court, Boston
Civil Engineering Technology (1972)

Richard L. Morin, B.S., M.S.
Research Associate, Northeastern University
Electrical Engineering Technology (1980)

*Louis J. Nardone, B.S., M.S., P.E. (Mass.)
Associate Professor, Electrical Engineering Tech., Northeastern Univ.
Program Coordinator for Electrical Engineering Technology
Lincoln College, Day and Evening Programs (1955)

Robert L. Norton, A.S., B.S., M.S., P.E. (Mass.)
Associate Professor Mechanical Engineering, Worcester Polytechnical Inst.
Computer Technology (1967)

*Ray O. Oglesby, B.S.Ed., M.S.Ed.
Teacher, Newton North High School
Mathematics (1967)

Yesugey Oktay, B.S., M.S., P.E. (Mass., N.Y., Cal., Me.)
Division Head, Mechanical & Structural Engineering, Boston Edison Co.
Civil Engineering Technology (1970)

Peter J. O'Neill, A.B., M.A.T.
Mathematics Instructor and Computer Science Instructor, Norwood High School
Mathematics (1977)

Douglas J. Ordway, B.A., M.Ed.
Teacher, Boston Public Schools
Mathematics (1975)

*Thomas J. Owens, A.B., M.Ed.
Instructor in Mathematics, Quincy High School
Mathematics (1952)

John P. Page, A.B., M.Ed., A.M.
Teacher of Mathematics, Boston Latin School
Mathematics (1980)

*William H. Parmenter, A.E., B.B.A.
Instructor, Newton North High School
Electrical Engineering Technology (1952)

Francis A. Pepicelli, A.E., B.S.
Engineer, Northrop Corporation
Mechanical Engineering Technology (1976)

**Appointed to the rank of Senior Lecturer*

Peter J. Philliou, B.S., M.S., J.D.
Director, Curriculum Center, Wentworth Institute
Mathematics (1967)

Walter J. Phinney, A.E., B.E.T., M.B.A.
Manager, Product Design, Raytheon Company
Mechanical Engineering Technology (1977)

Dominic A. Piccione, B.S., M.S.P.E. (Mass., Va.)
Senior Engineer, Stone & Webster Eng. Corp.
Mechanical Engineering Technology (1966)

*Norman C. Poirier, B.S., M.S., P.E. (Mass.)
Research Associate, Northeastern University
Electrical Engineering Technology (1966)

Donald J. Poulin, A.E., B.S.I.T., P.E. (Mass.)
Sr. Test Eng., Kollsman Inst., Merrimack, New Hampshire
Electrical Engineering Technology (1970)

*Daniel W. Pratt, B.S., M.S.
Director of Computer Science, Boston Latin School
Mathematics (1967)

*Charles H. Price, Jr., B.S., M.S.
Technical Staff, The Mitre Corporation
Course Consultant, Electrical Engineering Technology (1960)

William B. Pronk
Chief Flight Instructor, Wiggins Airways
Aeronautical Technology (1972)

Andrea Quintiliani, B.S., M.S.
Investment Programmer, Boston Safe Deposit & Trust Co.
Mathematics (1978)

James F. Regan, B.S., M.S., P.E. (Mass.)
President, Keefe & Regan Engineers, Inc.
Civil Engineering Technology (1972)

*Edward L. Rich, B.S., M.S., P.E. (Mass.)
Program Control Manager, Raytheon Company
Mechanical Engineering Technology (1956)

Robert J. Ritchie, A.E., B.S.
Computer Graphics Supervisor, Boston Edison Co.
Engineering Graphics (1980)

Alan S. Ross, A.A., A.S.E.T.
Technician, Electrical Engineering Dept.
Cable Television (1981)

Eric A. Roy, A.B., M.Ed., M.A.
Assistant Headmaster, Jamaica Plain High School
Mathematics (1967)

Thomas E. Ruden, B.S., M.S.
Physicist, Varian Associates, Inc.
Physics (1967)

*Thaddeus Sadowski, S.B., Ed.M.
North Quincy High School
Mathematics (1958)

*Leo D. Salvucci, A.B., M.Ed., M.S.T.
Math. Teacher, Boston Latin School
Mathematics (1965)

Richard P. Samuels, B.E.E., M.S.I.M., P.E. (Mass.)
New England Telephone
Mathematics (1970)

**Appointed to the rank of Senior Lecturer*

Charles A. Schuetz, A.B., M.Ed.
Assistant Principal, Don Bosco Technical High School
Physics (1980)

*Henry Schwartz, A.B., M.Ed., P.E. (Mass.)
Chief Engineer, CA-PRA Inc.
Physics (1958)

*Robert I. Serody, B.S.E.E., M.S.E.E., P.E. (Mass.)
Technical Staff, Mitre Corp.
Electrical Engineering Technology (1967)

*Ralph W. Sexton, B.S., M.S., P.E. (Mass., N.H.)
Senior Mech. Eng., Stone & Webster Eng. Corp.
Course Consultant, Mechanical Engineering Technology (1966)

*Walter S. Shields, B.S., Ed.M., M.S., M.Ed.
Mathematics Instructor, Needham Public Schools
Mathematics (1966)

John M. Slepetz, B.C.E., M.C.E., Ph.D., P.E. (Va.)
Research Civil Engineer, U.S. Army Materials and Mechanics Research Center
Mechanical Engineering Technology (1970)

*Malcolm V. Smith, B.S.
Director, Home Office & Field Benefits, New England Life
Mathematics (1959)

*S. Leonard Spitz, B.S., M.S., M.Ed., P.E. (Mass.)
Editor, Circuits Manufacturing Magazine
Mechanical Engineering Technology (1955)

Richard E. Sprague, B.B.A., B.S.C.E., M.B.A., Ed.M.
Assistant to the Dean, Department of Cooperative Education, Northeastern University
Academic Counselor (1967)

*Benjamin R. Stahl, B.A.
Senior Systems Analyst, Raytheon Data Systems Company
Computer Technology (1966)

*Joseph E. Steffano, Sr., B.S., M.S., M.B.A., P.E. (Mass., Vt., N.H., Conn., Me., R.I., N.Y., Pa.), R.L.S. (Mass., Conn., N.H., Me., R.I., Vt.)
Assistant Chief Structural Engineer, Stone & Webster Eng. Corp.
Civil Engineering Technology (1965)

James Steinberg, B.S.
Project Engineer, U.S. Department of Transportation
Computer Technology (1977)

*M. Carlton Storms, B.A., M.Ed.
Teacher, Braintree High School
Physics (1967)

*Raimundas Sukys, B.S., M.S.
Senior Research Associate in Electrical Engineering, Northeastern University
Course Consultant, Electrical Engineering Technology (1962)

Dexter E. Swift, B.S., M.Ed
Teacher, City of Lynn
Physics (1968)

*Maurice Temple, B.S., M.Ed., M.S.
Associate Professor of Physical Science, Boston State College
Mathematics (1956)

Richard W. Torian, B.S., M.Ed.
Chairman, Math. Dept., Ashland High School
Mathematics (1965)

Melvin W. Tracey, B.S., S.M.
Marketing Manager, EG&G
Mechanical Engineering Technology (1968)

**Appointed to the rank of Senior Lecturer*

*John S. Travia, B.S.E.E., M.S.E.E., M.S.E.M., P.E. (Mass.)
Senior Engineer, Raytheon Company
Electrical Engineering Technology (1965)

Herman Vandevenne, M.S.E.E., Ph.D.
Staff, Massachusetts Institute of Technology
Electrical Engineering Technology (1980)

John F. Videler, B.S., M.S.
Operations Engineer, General Electric Co.
Physics (1968)

David A. Walsh, B.S.E., M.Ed.
Secondary Math. Teacher, Westwood High School
Mathematics (1979)

Joel Weinstein, B.S.
System Sales & Marketing Manager, Arrow Electronics, Inc.
Course Consultant, Microprocessor Hardware (1977)

James Welch, B.S., M.S.
Res. Eng., Foxboro Co.
Computer Technology (1977)

Henry J. Whiffen, B.S.E.E.
Development Engineering Group Leader, BLH Electronics
Physics (1979)

*Willard B. Whittemore, B.S.C.E., Ed.M., C.A.G.S.
Director of Mathematics, Everett Public Schools (Retired)
Mathematics (1957)

*Joseph F. Willard, B.S., P.E. (Mass.), R.L.S. (Mass.)
Associate Civil Engineer, Massachusetts Department of Public Works
Civil Engineering Technology (1949)

*Albert G. Wilson, B.S., M.S., P.E. (Mass.), S.E. (Ill.)
Engineering Design Supervisor, Stone & Webster Eng. Corp.
Course Consultant, Mechanical Engineering Technology (1948)

Kenneth S. Woodard, B.S., M.E., A.I.G.I. (Federal)
Associate Professor, Design Graphics, Northeastern University
Director, Aeronautical Technology, Lincoln College.
Academic Counselor (1967)

Elliot Wyner, B.S., M.S., Ph.D.
Research Engineer, GTE Sylvania
Physics (1973)

Walter Zagieboylo, M.S., M.E., P.E. (Mass.), M.A.A.
Engineer, U.S. Army Natick Labs.
Mathematics (1969)

Walter P. Zanor, B.S.B.A.
Instructor, Everett High School
Mathematics (1967)

**Appointed to the rank of Senior Lecturer*

the governing boards and officers of the university

THE CORPORATION

Julius Abrams
William T. Alexander
William F. Allen, Jr.
* *Diana J. Auger

*Vincent Barletta
Allen G. Barry
Lincoln C. Bateson
*Roy H. Beaton
†F. Gregg Bemis
Beverly Ann Bendekgey
Robert P. Berkowitz
Alfred M. Bertocchi
Gerald W. Blakeley, Jr.
S. Whitney Bradley
Melvin B. Bradshaw
Rexford A. Bristol
Edward W. Brooke
*Frederick L. Brown
†George R. Brown
William L. Brown
William H. Bruce, Jr.
John L. Burns
Hyman H. Burstein
Victor C. Bynoe

*Louis W. Cabot
*Norman L. Cahners
*Thomas E. Cargill, Jr.
*Richard P. Chapman
Richard P. Chapman, Jr.
Robert F. Chick
Vessarios G. Chigas

Logan Clarke, Jr.
Livingstone N. Coakley
*David H. Cogan
Abram T. Collier
T. Paul Connolly
James J. Costello
Edward Creiger
H. James Crossan, Jr.

Roger C. Damon
Nelson J. Darling, Jr.
Melanie Dean
(Melanie C. Berger)
Virginia Schenkelberger
Devine
William O. DiPietro
Alfred di Scipio
Estelle Dockser
Dorothy Dodge
* *William R. Driver, Jr.

William S. Edgerly
*William Elfers
*Byron K. Elliott
*William P. Ellison
Robert Erickson

*Frank L. Farwell
Joseph D. Feaster, Jr.
*James V. Fetchero
*Eldred L. Field
Phil David Fine
Joseph F. Ford
Albert S. Frager
Brenda J. Furlong

Murray J. Gart
Paul W. Glennon
*Lloyd S. Glidden, Jr.
John L. Grandin

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

* *Donald B. Guy

*Allan M. Hale
Edmund Blair Hawley
Michael E. Haynes
Donald P. Hearth
James S. Hekimian
William Hellman
*Ernest Henderson III
Joseph E. Heney
James S. Herbert
Arnold S. Hiatt
Richard D. Hill
Thomas Hollis, Jr.
D. Brainerd Holmes
Robert W. Holmes
Hartwell G. Howe
John S. Howe
Howard M. Hubbard
*Carl R. Hurtig

Richard P. Johnson
*Robert L. Johnson
*Henry C. Jones

*George S. Kariotis
Walter B. Kelley
†Frances Kenerson
Edward M. Kennedy
Fenton G. Keyes
Calvin A. King
†Asa S. Knowles
Harvey C. Krentzman

Evelyn M. Lane
*John P. LaWare
*Joseph C. Lawler
Maurice Lazarus
Elma I. Lewis
*Kenneth A. Loftman
Edward A. Loring
*John Lowell
*Diane H. Lupean

*Roderick M. MacDougall
Robert C. Marini
Evelyn Marran
* *Lawrence H. Martin

M. Dorothy Massey
*George J. Matthews
Walter E. Mattson
*J. Edwin Matz
Peter H. McCormick
William J. McCune, Jr.
John G. McElwee
Katherine Seay McHugh
Percy M. McIntosh
Dominic Meo, Jr.
William C. Mercer
Don G. Mitchell
Donald H. Moore
Frank E. Morris
James A. Morris
* *Stephen P. Mugar

N. Laurence Nagle
William H. Nichols, Jr.
Kathryn M. Nicholson

Bernard J. O'Keefe
Stanley C. Olsen
James H. Orr
Ara Oztemel

*Augustin H. Parker
Edward S. Parsons
*Amelia Peabody
Theodore R. Peary
Lawrence T. Perera
Nicholas V. Petrou
Edward E. Phillips
*Thomas L. Phillips
Edward D. Phinney
Rudolph F. Pierce
Jerome M. Powell
Albert Pratt
John F. Prendiville
Peter W. Princi
*William J. Pruyn
George Putnam

Blanche M. Quaid
*Francis J. Quirico

William H. Raye, Jr.
Kathleen M. Rice
D. Paul Rich
Robert Riesman
R. Earl Roberson
Daniel J. Roberts
†Dwight P. Robinson, Jr.

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

Ralph B. Rogers
Ronald L. Rossetti
*Kenneth G. Ryder

Ernest J. Sargeant
David T. Scott
Donald W. Seager
Sydney Shaftman
James L. Shanahan
Robert E. Siegfried
*Dorothy M. Simon
Philip A. Singleton
Paul D. Slater
* *Donald W. Smith
*Farnham W. Smith
*Charlotte B. Smith
*George A. Snell
O. Phillip Snowden
*Bernard Solomon
Robert C. Sprague
Milton Stern
David B. Stone
*Ruth S. Stuart

H. Patricia Taylor
Lawrence I. Templeman
Charles H. Tenney II
Almore I. Thompson
Milton A. Thompson
W. Nicholas Thorndike
Alan D. Tobin
*D. Thomas Trigg
Paul E. Tsongas
Joseph F. Turley
†Chaplin Tyler

Samuel Wakeman
Martin F. Walsh
*An Wang
Lloyd B. Waring
James L. Waters
David T. Wendell
William C. White
*Robert H. Willis

Richard W. Young

* *Alvin C. Zises

*Member of the Board of Trustees
* *Honorary Trustee
†Lifetime Trustee, Emeritus

OFFICERS OF THE CORPORATION AND BOARD OF TRUSTEES

Robert H. Willis, Chairman
Norman L. Cahners, Vice Chairman
Frank L. Farwell, Vice Chairman
Farnham W. Smith, Vice Chairman
D. Thomas Trigg, Vice Chairman–Finance
Philip C. Boyd, Secretary
Byron K. Elliott, Honorary Chairman
William R. Driver, Jr., Honorary Vice Chairman
Dwight P. Robinson, Jr., Honorary Vice Chairman

BOARD OF TRUSTEES

Class of 1982
Frederick L. Brown
David H. Cogan
Frank L. Farwell
Lloyd S. Glidden, Jr.
Allan M. Hale
Henry C. Jones
J. Edwin Matz
Farnham W. Smith
George A. Snell
D. Thomas Trigg

Class of 1983
Vincent Barletta
Roy H. Beaton
Louis W. Cabot
Byron K. Elliott
Kenneth A. Loftman
John Lowell
Roderick M. MacDougall
Augustin H. Parker
Francis J. Quirico
Charlotte B. Smith
An Wang

Class of 1984
Thomas E. Cargill, Jr.
Eldred L. Field
Robert L. Johnson

George S. Kariotis
Diane H. Lupean
Amelia Peabody
Thomas L. Phillips
William J. Pruyn
Dorothy M. Simon
Bernard Solomon
Robert H. Willis

Class of 1985
Norman L. Cahners
Richard P. Chapman
William Elfers
William P. Ellison
James V. Fetchero
Ernest Henderson III
Carl R. Hurtig
John P. LaWare
Joseph C. Lawler
George J. Matthews
Ruth S. Stuart

Ex Officio
††Kenneth G. Ryder

Honorary Trustees
Diana J. Auger
William R. Driver, Jr.
Donald B. Guy
Lawrence H. Martin
Stephen P. Mugar
Donald W. Smith
Alvin C. Zises

Lifetime Trustees, Emeriti
F. Gregg Bemis
George R. Brown
Frances Kenerson
Asa S. Knowles
Dwight P. Robinson, Jr.
Chaplin Tyler

ADMINISTRATIVE ORGANIZATION

Officers of the University

Arthur W. Brodeur, B.S., *Vice President for Public Affairs*

John A. Curry, A.B., Ed.M., Ed.D., *Senior Vice President for Administration*

Edmund L. Deltano, B.A., *Vice President for Finance*

Asa S. Knowles, A.B., A.M., LL.D., Litt.D., Sc.D., D.B.A., Sc.D. in Bus. Ed., *Chancellor*

Melvin Mark, B.S., M.S., Sc.D., *Senior Vice President for Academic Affairs and Provost*

John Martin, B.S., M.B.A., *Vice President for Business*

John D. O'Bryant, B.S., M.Ed., *Vice President for Student Affairs*

Eugene M. Reppucci, Jr., B.S., M.Ed., *Vice President for University Development*

Daniel J. Roberts, B.S., M.B.A., Ed.M., *Senior Vice President-Treasurer*

Kenneth G. Ryder, A.B., M.A., L.H.D., *President*

Royal K. Toebes, B.S., M.B.A., *Vice President for Alumni Development*

Roy L. Wooldridge, B.S., Ed.M., *Vice President for Cooperative Education*

Academic Deans, Directors of Schools, and General Administrative Officers

Richard Astro, B.A., M.A., Ph.D., *Dean of the College of Arts and Sciences*

Maryann G. Billington, A.B., M.B.A., *Assistant Dean and Director of the Graduate School of Business Administration*

David H. Blake, A.B., M.B.A., Ph.D., *Dean of the College of Business Administration*

Philip T. Crotty, A.B., A.M., M.B.A., Ed.D., *Vice Provost*

Martin J. Damian, B.S., *Bursar*

Charles Devlin, B.S., M.Ed., *Dean of Student Financial Services*

Theodore N. Ferdinand, B.S., M.S., Ph.D., *Director of the Graduate Program in Criminal Justice*

Clifford J. Fralen, B.S., M.S.E., M.B.A., *Director of the Physical Plant*

William A. Frohlich, B.A., *Director of University Publishing Group and Director of University Press*

Job E. Fuchs, M.D., *Director of Health Services*

Joseph M. Golemme, S.B., M.A., C.P.A., *Director of the Graduate School of Professional Accounting*

Thomas E. Hulbert, B.Mgt.E., M.S., *Director of Lincoln College and Associate Dean of Engineering*

Ellen S. Jackson, B.A., Ed.M., C.A.G.S., *Dean and Director of Affirmative Action*

John W. Jordan, B.S., M.Ed., *Dean of University College*

Paul M. Kalaghan, A.B., M.S., Ph.D., *Dean of the College of Computer Science*

Christopher F. Kennedy, A.B., Ed.M., *Dean of Administration*

Philip LaTorre, B.S., M.S., *Dean of Personnel Services and Director of Environmental Health*

Paul M. Lepley, B.S., M.Ed., Ed.D., *Dean of Boston-Bouvé College of Human Development Professions*

Juanita O. Long, B.S.N., M.S.N., C.A.G.S., *Dean of Nursing*

Harold Lurie, B.S., M.S., Ph.D., *Dean of Engineering*

Philip McCabe, B.A., M.Ed., *Dean of Admissions*

Michael C. Meltsner, A.B., LL.B., *Dean of the School of Law*

Roland H. Moody, A.B., B.L.S., *Director of the University Libraries*

Edmund J. Mullen, B.A., M.Ed., *University Registrar*

J. Edward Neighbor, B.S., M.S., Ph.D., *Director of the Graduate School and Associate Dean of the College of Arts and Sciences*

John L. Neumeyer, B.S. Ph.D., *Director of the Graduate School of Pharmacy and Allied Health Professions*

Paul M. Pratt, B.S., M.Ed., *Dean of the Department of Cooperative Education*

John Proakis, B.S., M.S., Ph.D., *Director of the Graduate School of Engineering and Associate Dean of Engineering*

Edward W. Robinson, B.S., Ed.M., *Dean of Students*

Norman Rosenblatt, A.B., Ph.D., *Dean of Criminal Justice*

Jeanne L. Rowlands, B.A., B.S., M.A., *Director of Women's Athletics*

Gerald E. Schumacher, Pharm.D., M.Sc., Ph.D., *Dean of the College of Pharmacy and Allied Health Professions*

Janice Walker, A.B., *Assistant Dean and Director of the Graduate School of Boston-Bouvé College of Human Development Professions*

Karl Weiss, B.S., Ph.D., *Vice Provost*

Joseph Zabilski, B.S., *Director of Men's Athletics*

Academic/Administrative Council*

Kenneth G. Ryder, Chairman
John A. Curry, Vice Chairman
Melvin Mark, Vice Chairman
Barbara F. Burke, Secretary

Richard Astro
David H. Blake
Arthur W. Brodeur
Charles W. Coffin
Philip T. Crotty
Edmund L. Deltano
Clifford J. Fralen
Humberto F. Goncalves
Ellen S. Jackson
John W. Jordan
Paul M. Kalaghan
Christopher F. Kennedy
Roland E. Latham
Philip LaTorre
Paul M. Lepley
Juanita O. Long
Harold Lurie
Kathryn Luttgens
John A. Martin
Philip R. McCabe
Michael C. Meltsner
Christopher Mosher
John D. O'Bryant
Donald G. Porter
Paul M. Pratt
Eugene M. Reppucci, Jr.
Daniel J. Roberts
Edward W. Robinson
Norman Rosenblatt
Gerald E. Schumacher
Arthur D. Smith
Royal K. Toebes
Karl Weiss
Roy L. Wooldridge

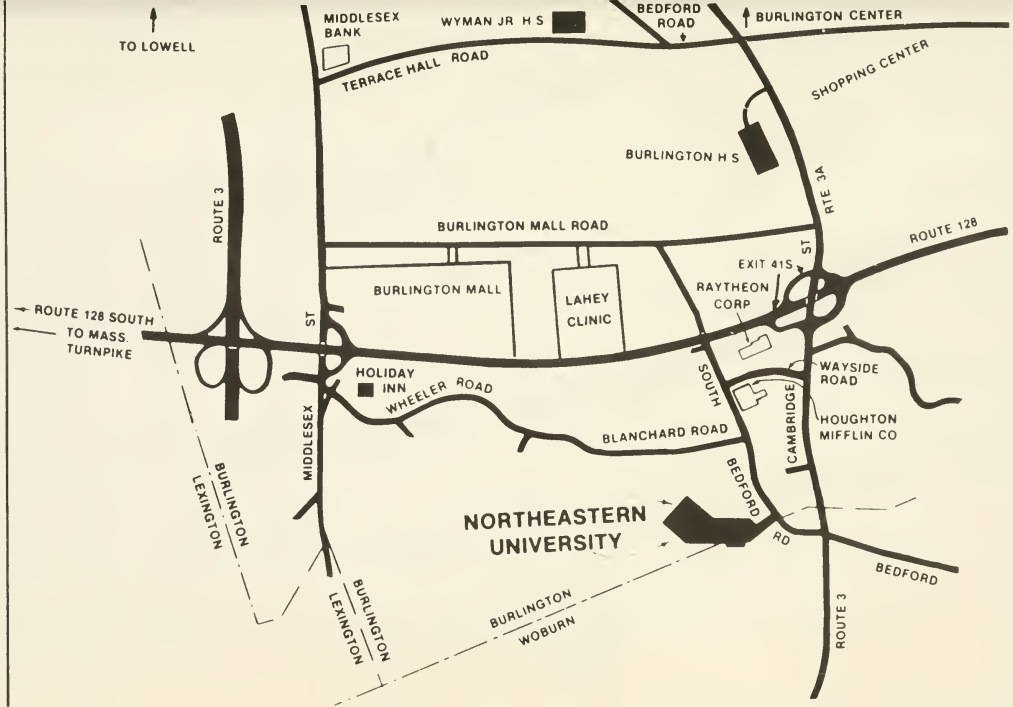
*Two faculty representatives to be selected by the Faculty Senate Agenda Committee.

The Faculty Senate

*Melvin Mark, Presiding Officer

George G. Adams
Samuel J. Bernstein
*David H. Blake
Franklyn K. Brown
Richard L. Canale
Holly M. Carter
Sangit Chatterjee
*John A. Curry
Arthur Davis, Jr.
Charles H. Ellis, Jr.
Steven E. Eriksen
Mary Florentine
Norbert L. Fullington
Harold M. Goldstein
Robert A. Gonsalves
Peter J. Graham, Jr.
Bart K. Gruzalski
Jessie L. Hansen
Jorge V. Jose
*Paul M. Kalaghan
Maurice Kaufman
Frank F. Lee
*Paul M. Lepley
*Juanita O. Long
*Harold Lurie
Bertram J. Malenka
Robert A. Millen
Stuart S. Peterfreund
Harlan D. Platt
*Paul M. Pratt
Donald J. Reaves
*Norman Rosenblatt
*Gerald E. Schumacher
Wallace W. Sherwood
Marilyn M. Smith
Michael R. Vaughn
Nancy Walden
Robert N. Wiener
John Zotos

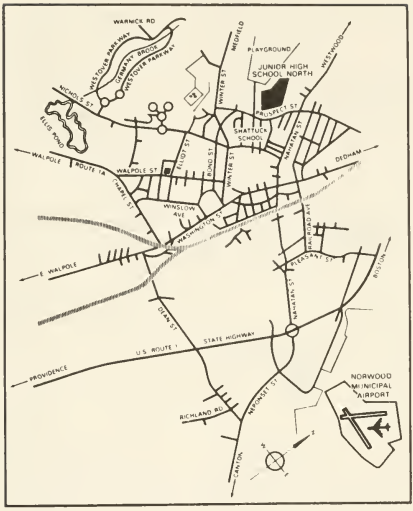
*Appointed by the President



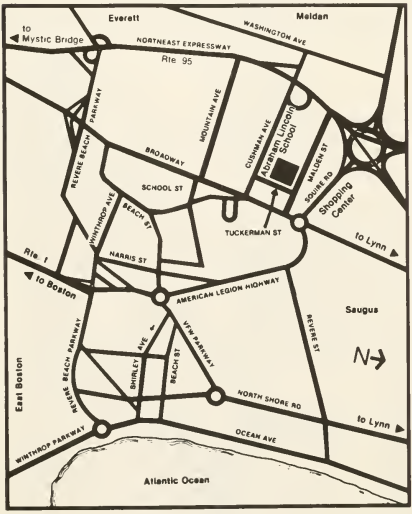
Suburban Campus

Framingham North High School

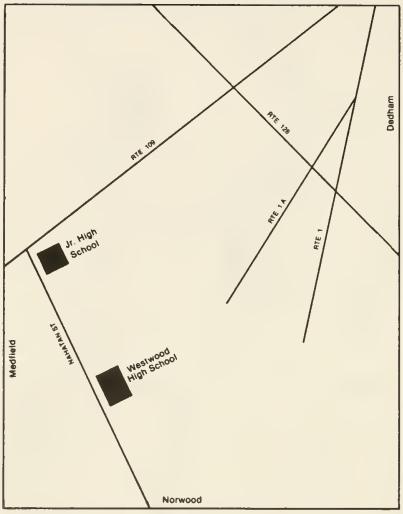
Norwood Junior High School North



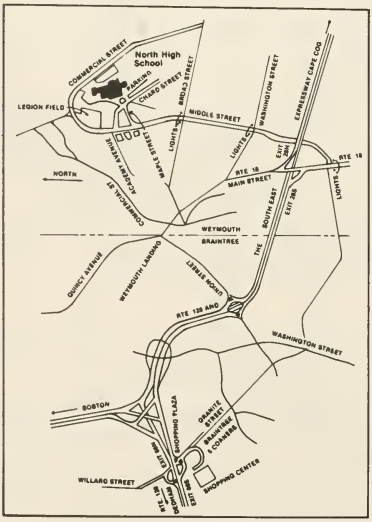
Revere (Abraham Lincoln School)



Westwood High School



Weymouth Schools



index

A

Academic and Professional Awards, 51
Academic Standards, 47
Address of Lincoln College, 5
Administration, Lincoln College, 31
Admissions, 41
Advanced Standing Credits, 43
Aeronautical Technology
  Program, 67
  Courses, 130
Affiliated Programs, 24
Alumni Information, 62, 63
Attendance, 45
Auditing Policy, 48
Awards, Academic and Professional, 51

B

Buildings and Facilities, 27

C

Calendar, 7
Campus Locations, 45
Certificates, 65
Chemical Engineering Technology
  Courses, 116
Civil Engineering Technology
  Programs, 70
  Courses, 96
Classification of Students, 42
Closing of University, Emergency, 13
Computer Technology
  Programs, 89
  Courses, 117
Continuing Education, Center for, 23
Cooperative Plan, 17
Counseling, 5, 41
Course Descriptions, 95
  Aeronautical Technology, 130
  Chemical Engineering Technology, 116
  Civil Engineering Technology, 96
  Computer Technology, 117
  Electrical Engineering Technology, 107
  Engineering Graphics, 121
  Industrial Engineering Technology, 116
  Mathematics, 122
  Mechanical Engineering Technology, 99
  Physics, 126
Courses, Index to, 96

D

Day Cooperative Programs, 81, 87
Day Programs for Adults, 24
Degrees, 65

E

Electrical Engineering Technology
  Programs, 77
  Courses, 107
Engineering, College of, 37
  Admission Requirements, 38
Engineering Graphics Courses, 121
Equal Opportunity Policy, 13
Examinations, Makeup, 46

F

Faculty, 137
Family Educational Rights and Privacy Act, 14
Fees, Special, 57
Financial Aid, 58

G

Grading System, 47
Graduate Schools, 21
Graduation Requirements, 50

H

Handicapped, Office of Services for, 13

I

Industrial Engineering Technology
  Courses, 116
Interdisciplinary Engineering and Science Technology Programs, 88
International Students, English for, 67
Interviews, 5

L

Learning Resources, Office of, 23
Library, 27
Loans, 58

M

Makeup Examinations, 46
Map of Campus, 6
  Suburban Maps, 160
Mathematics Courses, 122
Matriculation, 43
Mechanical Engineering Technology
  Programs, 82
  Courses, 99
Mechanical-Structural Engineering Technology, 92

O

Office Hours, 5

P

Pass-Fail Courses, 48
Physics Courses, 126
Placement Service, 63
Privacy Act, Family Educational Rights and, 14
Probation
  Scholastic, 50
  Disciplinary, 50
Proficiency Examinations, 44
Programmed Study, 67
Programs of Instruction, 65
  Aeronautical Technology, 67
  Civil Engineering Technology, 70
  Computer Technology, 89
  Electrical Engineering Technology, 77
  Interdisciplinary Engineering and Science Technology, 88
  Mechanical Engineering Technology, 88
  Mechanical-Structural Engineering Technology, 92
  Pre-Technology Preparation, 66

Q

Quality-Point Average, 48
Quarter Calendar, 45

R

Reading-Improvement Programs, 67
Registration, 44
Registration Dates, 6

S

Student Activities, 61
Structural Engineering Technology, 72
Supplemental Courses, 127
Surveying and Highway Engineering Technology, 74

T

Technologist, Description, 35
Textbooks and Supplies, 58
Transfer Students, 43
Tuition, 55

U

Undergraduate Colleges, 18

V

Veterans, Benefits, 57

W

Withdrawal, 46

WELLS LIBRARY
WALTHAM, MA 02154

NORTHEASTERN UNIVERSITY LIBRARIES DUPL
3 9358 01114467 9

NORTHEASTERN UNIVERSITY LIBRARIES
3 9358 01114467 9